BULL TROUT LIFE HISTORY INVESTIGATIONS IN THE NORTH FORK CLEARWATER RIVER BASIN

REGIONAL FISHERIES MANAGEMENT INVESTIGATIONS NORTH FORK CLEARWATER RIVER BULL TROUT

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ABSTRACT

A total of 252 bull trout *Salvelinus confluentus* were captured in Dworshak Reservoir in 2003. Thirty-four were recaptures; 13 were from unknown years due to Passive Integrated Transponder (PIT) tag failure or loss, 2 were tagged in 2001, 8 were tagged in 2002, and 11 were tagged earlier in 2003. All fish captured ranged in total length from 276 – 691 mm and weight ranged from 150 – 3,510 g. Of these 192 were radio-tagged. Peak migration from the reservoir occurred the week of June 10-16, 2003. The last fish was detected leaving the reservoir on August 1, 2003. The first fish was detected returning to the reservoir on September 8, 2003. Survival of fish, presumably post-spawners that migrated from Dworshak Reservoir in 2003 was estimated at 64%. The adult migratory population estimated at 1,587 (+/- 448.1) adults is restricted to fluvial adults in areas known to contain radio-tagged fish in the North Fork Clearwater River basin. Bull trout were first detected in the lower reservoir, less than 1 km from Dworshak Dam (rkm 3.1), in January 2003 and remained in this area through April. The majority of bull trout use in the reservoir during the overwintering period is from rkm 45.4 – 66.4 (Evans Creek to Grandad Bridge). There was a single radio-tagged bull trout entrained through Dworshak Dam. The entrainment event occurred in the month of April when outflow from the project was in excess of 453 m^3/s. Additional work will be completed in 2004 on bull trout in the lower Clearwater River and the NFC below Dworshak Dam to determine extent of losses due to entrainment.

PART I: BULL TROUT NORTH FORK CLEARWATER RIVER ABOVE DWORSHAK DAM

INTRODUCTION

In 1971 the construction of Dworshak Dam was completed near the mouth of the North Fork Clearwater River (NFC). The 218 m tall dam inundated greater than 100 km of riverine habitat on the mainstem of the NFC and its tributaries. In the absence of any fish passage facilities anadromous fish runs have been eliminated from the NFC above Dworshak Dam. Impacts on resident fish species in the basin are not as clear.

Historical observations document bull trout *Salvelinus confluentus* throughout the NFC basin. Bull trout were found in the basin prior to construction of Dworshak Dam (Cannon 1970) and are still found in the NFC, many of its tributaries and Dworshak Reservoir (Lindland 1987, Statler 1988, Schriever and Cochnauer 1996, Weigel and Cross 1997, Weigel and Zakrajsek 1998, Schriever and Schiff 2002, Schiff and Schriever 2004, Schiff 2004). However, measuring changes in bull trout population abundance and distribution in the basin is difficult because of the lack of pre- and post-dam data. There is also a lack of information on bull trout populations in basins without dam and reservoir influences to use as comparable controls. As a result, direct assessment of the change in bull trout population dynamics due to the construction of Dworshak Dam is likely not feasible. However, assessment of the status and structure of the current bull trout population remaining in the NFC basin is possible. Determining whether their viability and movements are affected by operations of Dworshak Dam and its physical attributes can also be determined. The investigation of these issues will help provide the information necessary to assess the need for, and determination of strategies to protect and perpetuate viable populations of bull trout in the NFC basin.

Bull trout populations are susceptible to habitat disruption and fragmentation (Rieman and McIntyre 1993). Dworshak Dam has possibly isolated bull trout population(s) in the NFC from genetic exchange with other populations in the Clearwater River basin and caused fragmentation of remaining NFC populations. The impact(s) of severing the connectivity between the NFC bull trout populations and other Clearwater River populations may be crucial in sustaining a viable bull trout population upstream of Dworshak Dam. Without more information, the disruption of this migratory corridor can be viewed as a threat to the persistence of bull trout populations in the NFC.

Since 2000, the Idaho Department of Fish and Game (Department) has been conducting extensive research on the migratory bull trout population existing above Dworshak Dam. This research has provided information on timing of migration, overall migration pattern and distribution throughout the drainage (Schriever and Schiff 2002, Schiff and Schriever 2004, Schiff and Schriever 2004). Current research is directed at determining the role Dworshak Reservoir plays in the life history, distribution and abundance of bull trout in the drainage.

This study was designed to document and describe bull trout life history, including their temporal and spatial distribution within the NFC drainage. This information will be used to develop and implement strategies to protect and perpetuate bull trout populations in the NFC drainage with regards to operation of Dworshak Dam and project area.

STUDY SITE

The NFC is a sixth order stream located in north-central Idaho (Figure 1). It has a total drainage area of 739,982 ha with the headwaters extending into the Bitterroot Mountains and forming the western border of Montana. The majority of the drainage is under public ownership by the US Forest Service (USFS) and the Clearwater National Forest (CNF). The major tributaries of the NFC are Little North Fork Clearwater River (LNF), and Kelly, Cayuse, Skull, Quartz, Floodwood, Stony and Weitas creeks (Figure 1).

At full pool Dworshak Reservoir is 86.2 km long and has 295 km of steep shoreline. It has a total volume of 4.28×10^9 m^3 that corresponds to a maximum depth of 194 m, mean depth at full pool of 56 m, and a surface area of 6,644 ha (Maiolie and Elam 1994). The main arms of the reservoir are Elk Creek, the LNF, and the NFC (Figure 1).

Native resident salmonids found within the drainage include bull trout, westslope cutthroat trout *Oncorhynchus clarkii lewisi*, rainbow trout *O. mykiss* and mountain whitefish *Prosopium williamsoni*. Anadromous fish have been eliminated from the NFC drainage since the construction of Dworshak Dam. Prior to that time, Chinook salmon *O. tshawytscha* and steelhead *O. mykiss* where found throughout the drainage. Dworshak Reservoir has been stocked with kokanee *O. nerka*, rainbow trout, brook trout *Salvelinus fontinalis,* westslope cutthroat trout, bull trout, smallmouth bass *Micropterus dolomieui*, and largemouth bass *M. salmoides.*

OBJECTIVES

1. Obtain basic biological and life history information on bull trout in Dworshak Reservoir and the NFC drainage.

2. Determine migration patterns of bull trout within the NFC.

3. Determine spatial and temporal distribution of bull trout within Dworshak Reservoir and the NFC drainage.

4. Identify bull trout spawning sites within the NFC.

5. Determine the number of adult bull trout annually migrating from Dworshak Reservoir.

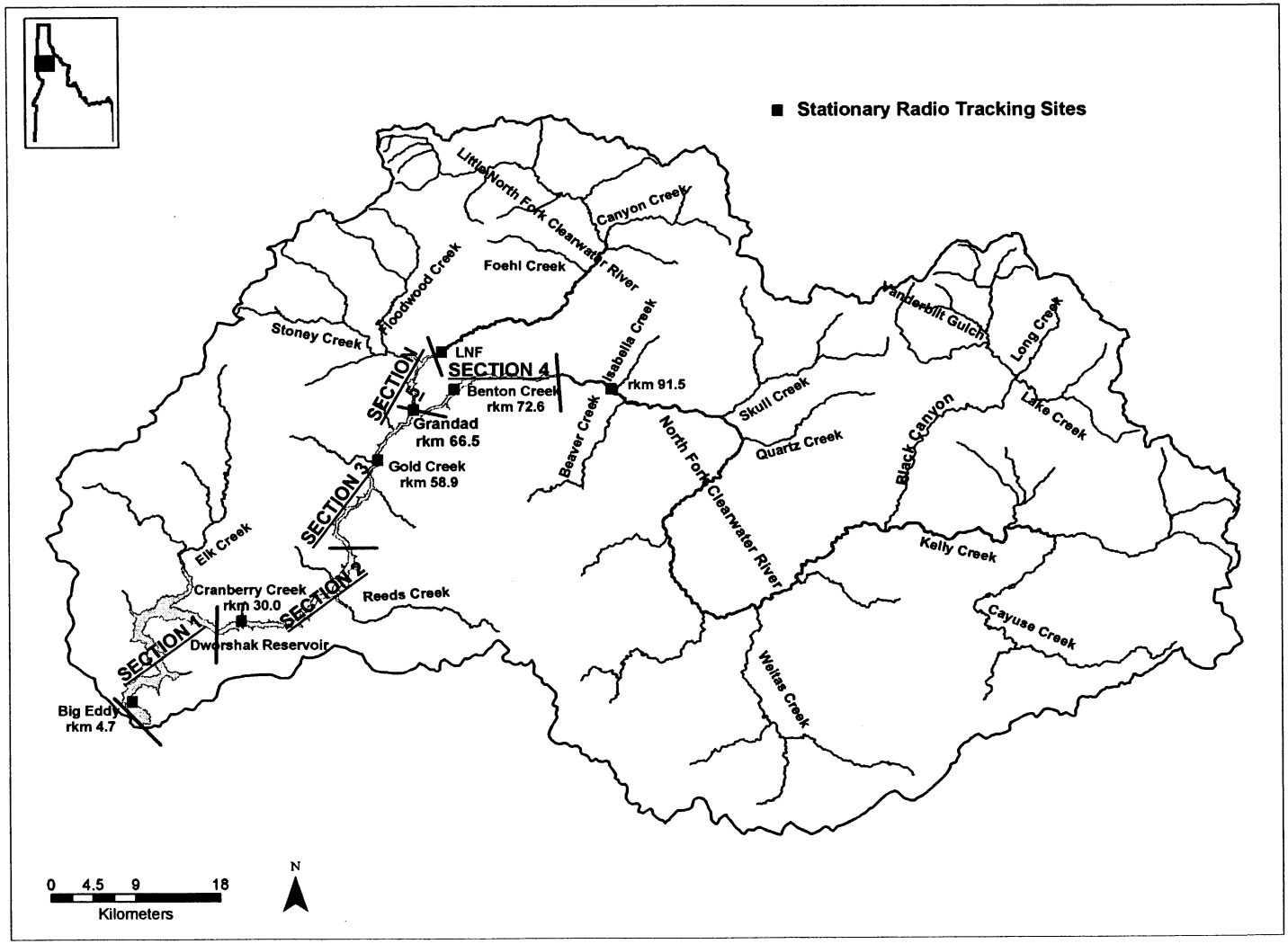

Figure 1. Study area, North Fork Clearwater River, Idaho. Radio and acoustic fixed sites are denoted in their approximate locations. Sections are delineated for overwintering in Dworshak Reservoir.

METHODS

Tagging

Bull trout were captured with hook-and-line and gill nets in the NFC and LNF arms of Dworshak Reservoir near the slack water/flowing water interface, where bull trout concentrate in early spring. Experimental gill nets were used consisting of six 7.6 m long panels. Each panel was one of six mesh sizes. The mesh sizes were 19 mm, 25 mm, 32 mm, 38 mm, 51 mm, and 64 mm. Sampling was conducted in the NFC arm between rkm 74.1 and rkm 85.8 (area 1), in the LNF arm 5.5-8.0 km above the confluence of the LNF and NFC (area 2), at the slackwater interface in Breakfast Creek, approximately a 3 km area (area 3), (Figure 2). Additional bull trout were collected in Dworshak Reservoir between Elk Creek (rkm 20.1) and Grandad Bridge (rkm 64.4) (area 4) (Figure 2).

Sampling was conducted in areas 2 and 3 and in the mainstem NFC from Isabella Creek (rkm 91.9) to Pete Ott Creek (rkm 171.6) in October 2003 (Figure 2). This sampling was conducted to tag post-spawn bull trout returning to the reservoir and increase the number of radio-tagged bull trout in the reservoir during the winter.

Individual bull trout were anesthetized in a 60-80 mg/l solution of MS222. Fish were initially weighed and measured. All fish were scanned for PIT tags. If a fish was not previously PIT tagged, a 134 kHz PIT tag was inserted in the opercula muscle using a 14-gage hypodermic needle. Also, a fin clip was removed for genetic sampling. If the fish was previously PIT tagged the number was recorded. Scales were collected from all bull trout to determine age and verify a recaptured fish's age. The first pelvic fin ray on the left fin was removed for verification of age and growth information acquired from scales.

Bull trout weighing greater than 190 g were candidates for surgical radio transmitter implantation. The surgical procedure is an adaptation of the shielded-needle technique as described by Schill et al. (1994). All individuals were allowed to recover in fresh water for a minimum of 15 minutes prior to release.

CAFT-transmitters are acoustic transmitters. The acoustic transmitter allows for detection in water depths greater than 10 m and near the surface. They were used to monitor bull trout in the reservoir throughout the year. The limitation of the CAFT-transmitters is its inability to be tracked from a fixed-wing airplane, because it is an acoustic transmitter it does not send out a radio signal that can be detected from the air. To increase the probability that CAFT-tagged bull trout would remain in the reservoir we only implanted CAFT-transmitters into bull trout caught in October. We assumed bull trout caught at this time period were returning to Dworshak Reservoir to overwinter.

Fish with radio transmitters implanted were also subject to maturity and sex determination. An otoscope was used to visually determine gender and maturity. The instrument was inserted into the incision created for transmitter implantation. Once inserted into the body cavity, mature reproductive organs, if present, were generally observed. If no reproductive organs were observed, the otoscope followed the body wall down dorsally and anteriorly toward the head, following the kidney. Immature reproductive organs were generally found lying along the body wall posterior to the liver. If no reproductive organs were observed, it was recorded as unknown. A female was determined to be mature if large ripe eggs (greater than one mm diameter) were observed and immature if small eggs (less than one mm diameter) were observed. Males were identified as mature if large gonads were observed and immature if gonads were small.

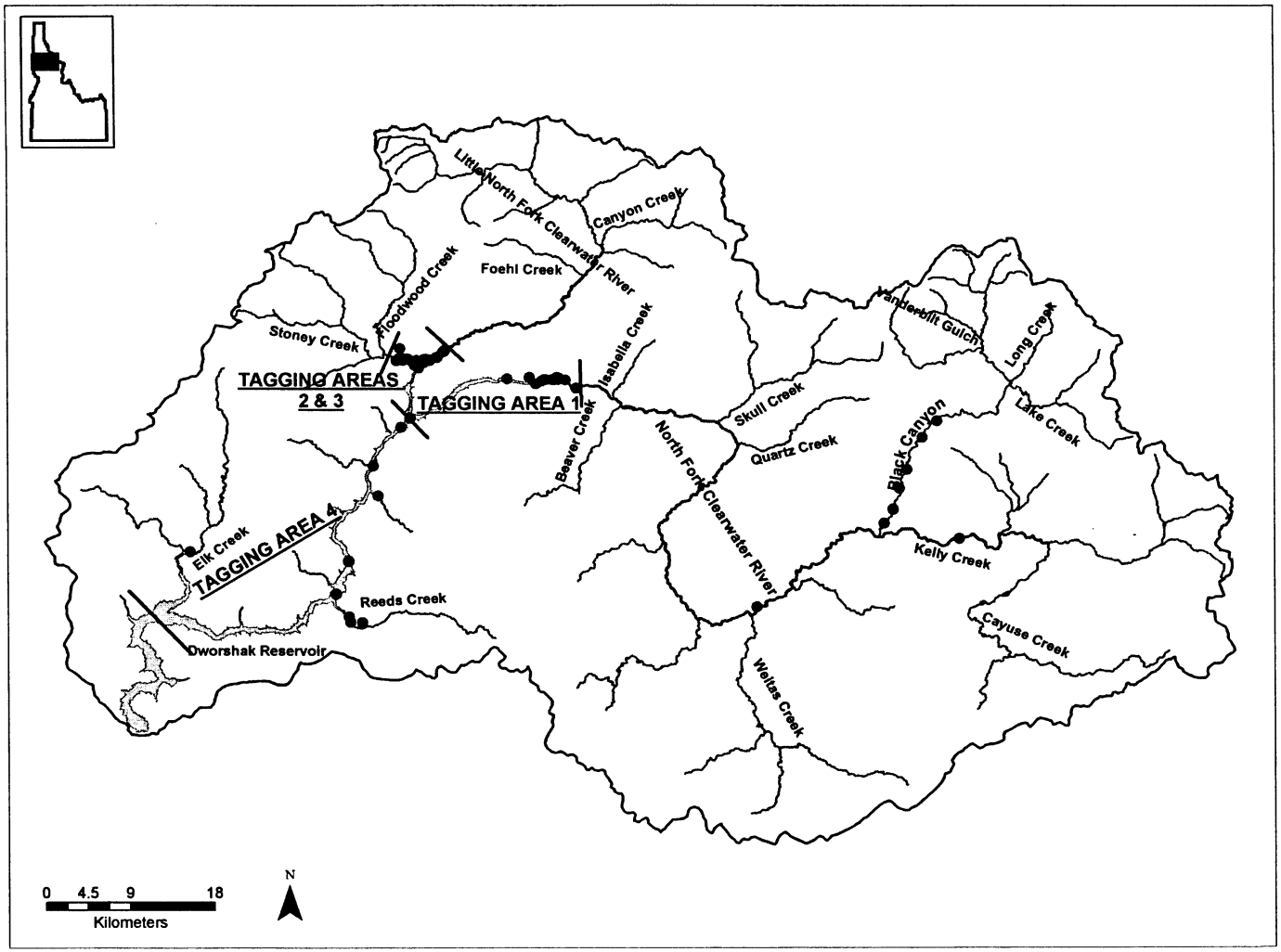

Figure 2. Tagging locations for all bull trout captured in the North Fork Clearwater River, 2003. Multiple fish were tagged at any given tagging location.

Tracking and Distribution

Boat and fixed-wing aircraft were utilized biweekly to monitor fish in Dworshak Reservoir. Additional tracking in riverine sections of the study area was completed using automobiles, fixed-wing aircraft and hiking. In addition to mobile tracking we established seven stationary radio and/or acoustic receiving sites. Five combination radio-acoustic stationary receiving sites were located in Dworshak Reservoir. These sites were located across from Big Eddy Marina (rkm 4.7), downstream of Cranberry Creek (rkm 30.0), downstream of Gold Creek (rkm 58.9), at the LNF/NFC confluence (rkm 66.5), and above Benton Creek (rkm 72.6) (Figure 1). The remaining two sites only received radio signals. The NFC fixed site was located at rkm 91.5, approximately 400 m downstream from the mouth of Isabella Creek (Figure 1). The LNF fixed site was located 10.0 km from the confluence of the LNF and NFC (Figure 1). This site was approximately 1.0 km upstream of Dworshak Reservoir (at full pool). We classified bull trout as leaving or entering the reservoir when they were initially recorded on either the NFC or LNF receivers on its upstream or downstream migration.

Temporal and spatial distribution of radio- and acoustic-tagged fish was grouped into three time periods based on bull trout life history patterns and the different habitats that are used during these time periods. The three time periods are: May through July (migration), August 15 through October 15 (spawning) and November through April (overwinter). To further define reservoir use during the overwinter time period, Dworshak Reservoir was broken into five sections. The sections are defined as follows: Section 1, Dworshak Dam (rkm 3.1) upstream to Dent Bridge (rkm 24.0); Section 2, Dent Bridge to Evans Creek (rkm 45.4); Section 3, Evans Creek to Grandad Bridge (rkm 66.4); Section 4, the NFC arm of the reservoir (rkm 66.5 – 89.5); and Section 5, the LNF arm of the reservoir (rkm 66.5 – 74.3) (Figure 1). Throughout the study period acoustic-tagged fish were only tracked in Dworshak Reservoir because it was impossible to track the acoustic signals in the riverine environment. The assumption is that radio- and acoustic-tagged fish behave in similar manners and would display similar patterns, but due to the limitations of the transmitter type are not detected at the same interval. For example, more acoustic transmitter detections are recorded in Dworshak Reservoir during the overwintering period because fish inhabit deeper depths where the radio transmitters are not detectable. We assume there are radio-tagged fish distributed at a similar frequency but not detected. The same assumption is made in the riverine environment regarding the distribution of acoustic-tagged fish even though they are not detected.

We used the 5th field Hydrologic Unit Code (HUC) described by the USGS (1982) to define geographical areas of local spawning populations. HUCs were used because they were the best geographical representation that we could easily determine. Radio-tagged bull trout were delineated into these HUCs based on their furthest documented upstream location or their location at the time of spawning.

Population Estimate

Adult bull trout population estimates were conducted when the fish were in pre-spawning aggregates in riverine habitat. Population estimates were conducted using a random sampling design that incorporates radio tracking and snorkeling techniques. A section of stream was flown to identify the location of radio-tagged bull trout. The GPS coordinates were recorded when a radio transmitter was detected. A field crew would then locate the GPS coordinates on

the ground within one to six days after the flight. Through triangulation methods, the transmitter's position would be pinpointed to within a 10 m section of stream. A primary 100 m transect was established that included the 10 m section of stream containing the radio transmitter(s). This primary transect would be snorkeled, beginning and ending at natural habitat breaks. Snorkel surveys were completed using one to six people, depending on the width and visibility of the stream at the transect location. Snorkelers would enter the river downstream of the transect, form a straight line, perpendicular to the flow and proceed upstream to the top of the transect. Snorkelers identified all fish observed. Species and total lengths (to the nearest inch) were recorded. Bull trout observed were recorded as being radio-tagged, adipose clipped or neither. Special notation was made when a bull trout was observed but total length, presence of radio transmitter or fin clip were not confirmed. When a radio-tagged bull trout was not observed in the transect, the area was searched further to determine if the transmitter was still in a live fish that was missed by snorkelers, or if the signal was from a transmitter only. When we found a transmitter no longer associated with a fish, we noted the location of the transmitter and any indication of cause of mortality.

Secondary, randomly chosen transects, were snorkeled in addition to primary transects. The secondary transects were sampled to determine the bias of selecting locations known to have radio-tagged fish in them. The length of each stream containing radio-tagged fish was measured using MAPTECH Terrain Navigator 2002. The stream length was used as the bounds in Microsoft Excel's random number generator software to select the secondary transects. For example, Isabella Creek had radio-tagged fish in it from its mouth upstream 6.5 km. Therefore, the range set in Excel would be 0.0 to 6.5. If the random number selected was 3.2, the transect snorkeled would start within the second 100 m of the third km. All stream calculations were completed in an upstream direction. The secondary transect was snorkeled and fish recorded in the same manner as the primary transect, but it was not searched for radio-tagged fish prior to being snorkeled.

The number of adult bull trout (those > 350 mm) was estimated using the ratio of radio-tagged and non-radio-tagged bull trout observed in a 100 m transect. The following equations were used to generate a population estimate in areas where documented pre-spawning aggregates of bull trout occur. The length of these stream reaches was estimated using MAPTECH Terrain Navigator 2002. The ratio estimate equation used for a simple random sample of transects was (Schaeffer et. al. 1996):

$$\hat{R} = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} x_i}$$

where y_i = the number of non-radio-tagged bull trout observed in the ith 100 m transect

x_i = the number of radio-tagged bull trout observed in the i^{th} 100 m transect

The variance of the ratio estimate was:

$$\hat{V}\left(\hat{R}\right)=\frac{1}{n\bar{x}^{-2}}\left(\frac{N-n}{N}\right)\left(\frac{\sum_{i=1}^{n}\left(y_i-\hat{R}x_i\right)^2}{n-1}\right)$$

where n = the number of 100 m transects completed

N = the number of 100 m transects in the spawning aggregate areas.

The equation for the ratio estimator of the population total was:

$$\hat{\tau}_y = \hat{R}\,\hat{\tau}_x$$

The variance of the estimator for the total was:

$$\hat{V}\left(\hat{\tau}_y\right)=\tau_x^2\,\hat{V}\left(\hat{R}\right)$$

Redd Surveys

Redd surveys were conducted from the last week of August until the end of September. Tributaries to be surveyed were selected based on the occurrence of radio-tagged bull trout either in the tributary or in the mainstem near a tributary mouth. Observers walked stream reaches and identified redds and recorded their physical attributes and their GPS coordinates. Occurrence of bull trout on the redd or in the stream was also recorded.

RESULTS

Tagging

From 13 April to 16 June 2003, 192 bull trout were captured within Dworshak Reservoir (Appendix A, Table 1). An additional 60 bull trout were collected from October 2 through 30, 2003 in Dworshak Reservoir and the NFC. Thirty-four bull trout were recaptured, of which 12 were not previously radio-tagged but were subsequently radio-tagged (Table 1). We were unable to verify through PIT tag identification which year 13 recaptures were initially captured because of PIT tag loss or malfunction. Out of the 13 recaptures, five were previously radio-tagged; however their transmitters were no longer functioning. Of the fish we could identify; two were initially captured and radio-tagged in 2001, five in the spring of 2002 (four of which were radio-tagged), and three in the fall of 2002 (one was CART-tagged). Additionally, ten fish were recaptured 1 to 16 days after initial tagging in the spring of 2003, and one was recaptured three days after initial tagging in the fall of 2003. Total length of all captured bull trout, including all recaptures, in 2003 ranged from 276 mm to 691 mm (Figure 3, Table 2) and weight ranged from 150 g to 3,510 g (Figure 4, Table 2). Radio transmitters were implanted in 192 bull trout, 143 in the spring, and 49 in the fall (Table 1). Tagging related mortality was estimated at 8% (12/143) during spring tagging. This estimate includes all transmitters that were not detected after initial tagging, or at any time in the 2003 field season, and those that were not detected moving from their tagging location.

Eighty-eight percent (222/252) of the bull trout were captured in the slack water interfaces in the NFC and LNF arms of Dworshak Reservoir (Figure 2, Table 1). Twelve percent (29) of the fish were captured at large in the reservoir (Figure 2, Table 1). An additional 30 fish (12%) were captured in the mainstem NFC in the fall (Figure 2, Table 1). Ninety-seven bull trout were implanted with MICRO-transmitters, 46 with NANO- transmitters, and 49 with CAFT-transmitters (Table 1).

Table 1. Total number of bull trout captured, recaptured and implanted with radio transmitters in 2003 by tagging group and transmitter type. The recaptures under each year indicate fish initially PIT-tagged in that year and recaptured in 2003.

		Recaptures				Transmitter Type				Sub-basin Located in After Migration[a]					
Tagging Group	Total Captured	Unknown	2001	2002	2003	NANO Spring	MICRO Spring	CAFT Fall	Total Radio-tagged	NFC	LNF	BFC	Dworshak	Not Detected After Tagging	Mortalities
Area 1: NFC	70	5	1	2	4	17	45	1	63	55*	4*		2	2	4
Area 2: LNF	75	8	1	6	7	10	29	16	55	2	34*	1*	1	1	2
Area 3: BFC	48					15	5	5	25	4	8*	8*	1		
Area 4: Dworshak	29					4	18		22	11	5		2		4[b]
NFC mainstem	30							27	27						
Total	252	13	2	8	11	46	97	49	192	71	49	9	6	3	10

[a] Does not include fish CAFT-tagged in the fall.

[b] One mortality was from an osprey. Transmitter was determined to be in an osprey nest.

* Indicates fish that moved into two different sub-basin during the year.

Table 2. Summary statistics of total length and weight for all bull trout captured in the North Fork Clearwater River drainage, 2003.

	Total Length (mm)	Weight (g)
Mean	434.3	828.7
Median	431.0	712.5
Mode	375.0	350.0
Standard Deviation	79.7	529.2
Minimum	276.0	150.0
Maximum	691.0	3,510.0
Sample Size	250.0	250.0

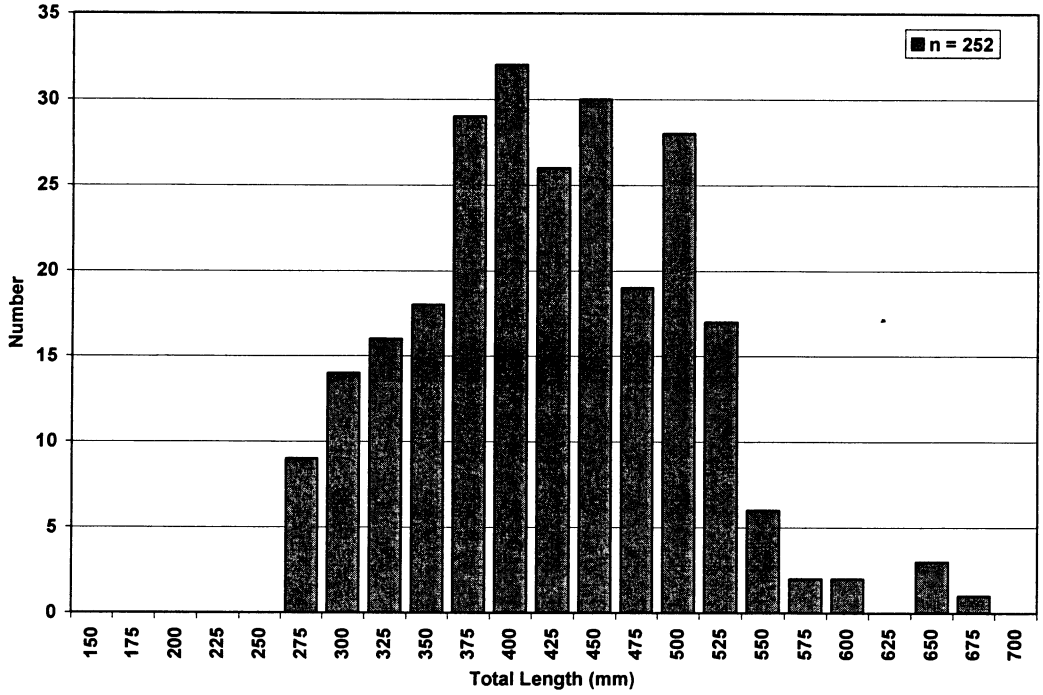

Figure 3. Total length distribution for all bull trout captured in the North Fork Clearwater River drainage, 2003.

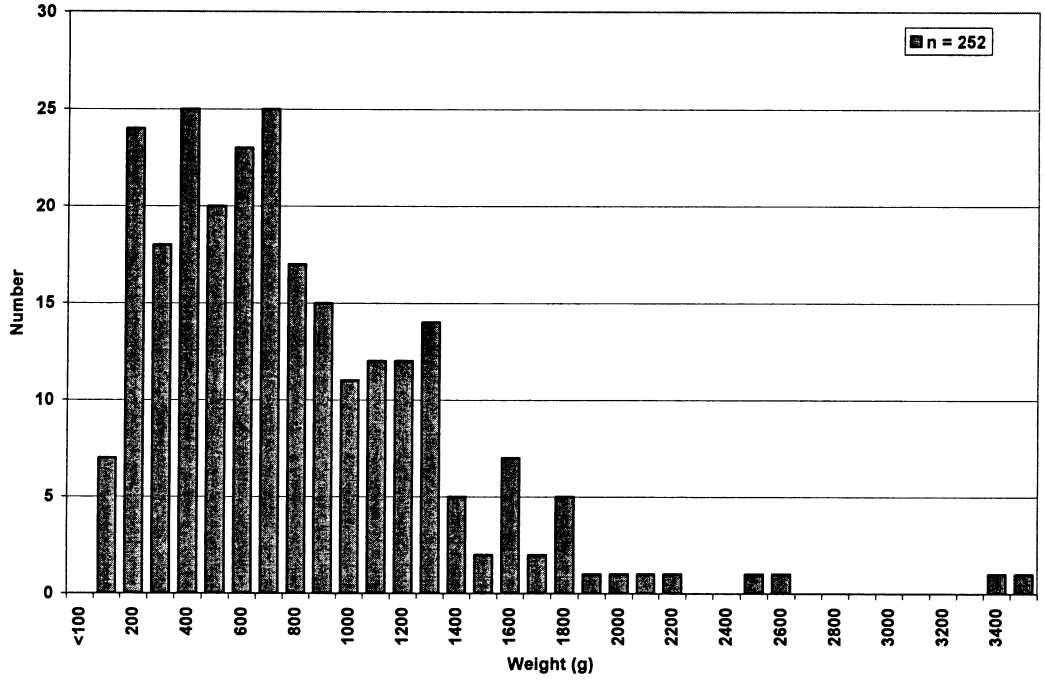

Figure 4. Weight distribution for all bull trout captured in the North Fork Clearwater River drainage, 2003

Migration Timing and Patterns

Migration from the reservoir was first documented on June 10, 2003 when the first radio-tagged bull trout was detected at the LNF receiver (Appendix A, Table 2). There were no fish detected leaving the reservoir prior to this time due to faulty programming of the NFC fixed sites. Subsequent tracking upstream of the fixed sites confirmed that fish did leave prior to June 10, but the exact date is unknown. The detected peak of upstream migration was the week of June 10-16 (Figure 5). By 7 July 2003, 95% of all bull trout that would migrate out of the reservoir had moved above the fixed sites and were in riverine habitat (Figure 5). On August 1, 2003 the last fish was detected leaving Dworshak Reservoir (Figure 5, Appendix A, Table 2). Radio-tagged fish that moved upstream to riverine habitat reached their furthest upstream location by September 15, 2003 (Appendix A, Table 2). Radio-tagged bull trout migrated an average upstream distance of 65.1 km (range = 3.8 – 179.6 km) (Appendix A, Table 3). The first radio-tagged bull trout was detected in a known spawning tributary on July 21, 2003, with the last bull trout to enter a spawning tributary on September 15, 2003 (Appendix A, Table 2). Individual bull trout may enter a tributary for a few days to spawn, but are not detected in a tributary due to our biweekly tracking schedule.

The first downstream migrating bull trout, possibly post-spawner, to pass a fixed site station was document on September 8, 2003 on the NFC receiver (Figure 5, Appendix A, Table 2). By October 20, 2003, 71% of the fish detected returning to the reservoir had moved passed a fixed site. The peak of downstream migration occurred during the week of October 14-20, 2003 (Figure 5). Forty-five bull trout were detected returning to the reservoir before the fixed sites were removed the first week of November 2003 (Figure 5, Appendix A, Table 2). Subsequent tracking has detected an additional 38 bull trout returning to the reservoir however their exact date of return is unknown.

During spring tagging 62 bull trout were tagged in area 1 (Figure 2). Two fish were not detected after initial tag implantation. Fifty-four of these fish migrated above the fixed site on the NFC (Table 1). One fish initially migrated into the NFC drainage, however by mid-July it had returned to the reservoir and migrated into the LNF drainage. Three of the remaining fish tagged in area 1 migrated directly into the LNF drainage and two migrated or remained in Dworshak Reservoir (Table 1). We suspected that four fish died because their transmitters were not detected moving from their tagging locations.

We radio-tagged 39 bull trout in area 2 during spring tagging (Figure 2, Table 1). One was not detected after tagging. Additionally, two fish did not move after tagging and are believed to be tagging related mortalities. Thirty-three fish migrated upstream of the LNF fixed site and remained in the LNF drainage (Table 1). One fish initially migrated from this area and into the BFC drainage, but by late July returned to the reservoir and migrated into the LNF drainage. Two fish migrated from tagging area 2 into the NFC drainage (Table 1). One fish tagged in area 2 remained in Dworshak Reservoir throughout 2003. The majority of bull trout tagged in the NFC and LNF (areas 1 and 2) tagging areas migrated upstream into the tributary most closely associated with the tagging area.

Twenty bull trout were radio-tagged in area 3 (Figure 2). All tagged fish were detected after initial tag implantation. Seven fish migrated to, and remained in, each of the BFC and LNF drainages (Table 1). One fish initially migrated into the BFC drainage but in midsummer it

migrated into the LNF drainage. Four of the remaining fish migrated into the NFC drainage and one remained in Dworshak Reservoir (Table 1).

Twenty-two bull trout were radio-tagged in area 4 (Figure 2). All were detected after initial tag implantation (Table 1). However, four are believed mortalities, three related to tagging and one was located in an osprey nest. Eleven of the remaining fish migrated into the NFC, five migrated into the LNF, and two remained in Dworshak Reservoir (Table 1).

An additional 49 bull trout were tagged with acoustic transmitters in October in areas 1, 2, 3 and the mainstem NFC (Figure 2, Table 1). All of these fish were detected in Dworshak Reservoir.

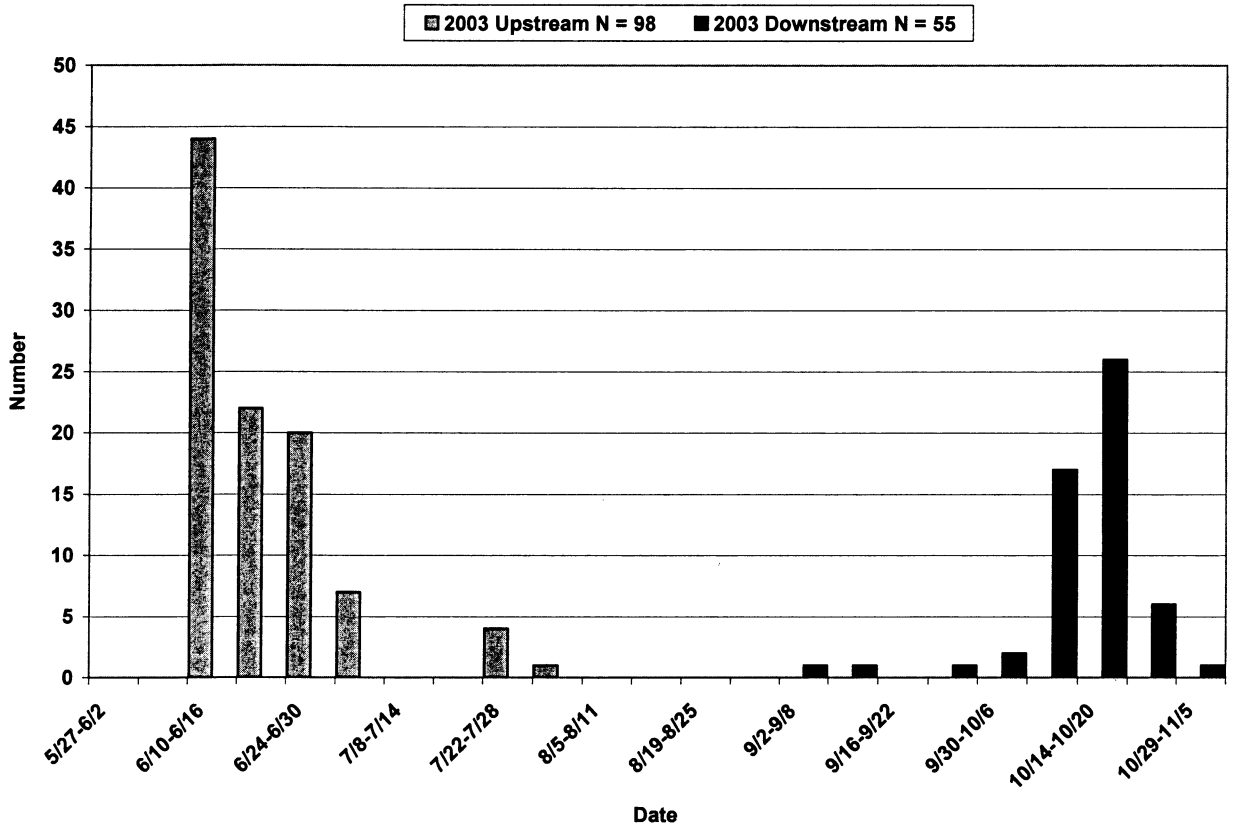

Figure 5. Bull trout migration timing past a fixed site as determined by radio telemetry. Fixed sites were installed May 15, 2003 and removed on November 15, 2003.

Temporal and Spatial Distribution

Temporal distributions of radio- and acoustic-tagged fish were grouped into three periods: May through July (upstream migration), August 15 through October 15 (spawning and downstream migration) and November through April (overwinter).

Migration Period

During the migration period 186 individual fish were detected a total of 641 times. The majority of these detections (300) were spatially distributed in Dworshak Reservoir (Figure 6). Of the 300 detections in Dworshak Reservoir 50% (151) were in the NFC reservoir arm, 31% (92) were in the LNF reservoir arm, and the remaining 19% (57) were between the Dworshak Dam and Grandad Bridge. During the migration time period the remaining detections were spatially distributed as follows: 23% (147) in the LNF above full pool elevation, 5% (29) were located in Floodwood and Stony creeks, 26% (165) were detected in the NFC above full pool elevation (Figure 6). Of the 165 detections in the NFC above the reservoir, 43% (71) were detected in tributaries (Figure 6).

Spawning Period

During the spawning period, 166 individual fish were detected. Forty percent (67/166) of these detections were located in the mainstem LNF or NFC (Figure 7). The LNF mainstem from the mouth of Canyon Creek to the headwaters contained 23% (38/166), the LNF mainstem from the LNF fixed site to Canyon Creek contained 7% (12/166), and the NFC mainstem contained 13% (13/166) (Figure 7). The greatest numbers of detections were located in tributaries, 43% (71/166) (Figure 7). There were 59 detections in tributaries of the NFC; 4 in tributaries of the LNF; 6 in Floodwood Creek, and 2 in Stony Creek (Figure 7). Also, during the spawning time period, 16% (28/166) were located in Dworshak Reservoir (Figure 7), all reservoir detections were from acoustically tagged fish.

Overwintering Period

During the overwintering period, extending from November 2002 to April 2003, 297 radio and acoustic transmissions were detected. In November 69 detections were recorded, 49 were radio and 20 were acoustic transmitters (Table 3). Fifteen detections were in riverine habitat and the remaining 54 detections were in Dworshak Reservoir. The majority of detections, 37, were in the NFC and LNF arms of the reservoir (Table 3, Figure 7). There were 11 detections in Section 3 and 6 in Section 2 (Table 3, Figure 8). It is believed that during November fish are still migrating downstream to overwintering locations, therefore fish are still heavily detected in the upper reservoir and riverine sections. All 22 detections in December were in the reservoir, 82% were acoustic and 18% were radio transmitters. Ten were detected in Section 4, 5 in Section 5, and 7 in Section 3 (Table 3, Figure 8). During November and December personnel were learning how to use the new acoustic tracking equipment. This caused a limited number of acoustic detections in the first two months. The few radio detections in December are related to fish descending into deeper depths when they are in the reservoir.

In January 2003, there were 57 detections, 27 acoustic and 30 radio transmitters (Table 3). The majority of detections, 31, were in Section 3 (Figure 9). This is the first time that bull trout are documented in the lower two sections of Dworshak Reservoir, five in Section 1 and 13 in Section 2 (Table 3, Figure 9). There were 26 detections in February all in the reservoir, 6 acoustic and 20 radio transmitters (Table 3). Similar to the previous month, the majority of detections, 12, were in Section 3 (Table 3, Figure 9). There were three detections in Section 1, five in Sections 2 and 4, and 1 detection in Section 5 (Table 3, Figure 9).

In March, there were 59 detections, 20 from acoustic transmitters and 39 from radio transmitters (Table 3). The greatest numbers of detections were in the lowest sections of Dworshak Reservoir, 25 in Section 2 and 14 in Section 1(Table 3, Figure 10). The remaining detections were distributed as follows: 12 in Section 3, 5 in Section 4, 2 in Section 5, and 1 in the LNF above Dworshak Reservoir (Table 3, Figure 10). In April, there were 64 detections, 16 acoustic and 48 radio transmitters (Table 3). The majority of detections were in Sections 4 and 5, the upper arms of the reservoir, 17 and 22, respectively (Table 3, Figure 10). This is predictable because bull trout are known to congregate in the NFC and LNF arms of the reservoir at this time of year. Also, tagging of additional fish began mid-month and is generally concentrated in these areas. However, there were still detections throughout the reservoir. These detections were distributed as follows: 4 in Section 1, 14 in Section 2, and 6 in Section 3 (Table 3, Figure 10).

Radio and acoustic tagged bull trout were distributed in 21 watershed groups throughout the study area (Table 4). The watershed groups within the NFC sub-basin were Headwaters NFC and Beaver, Cayuse, Cold Springs, Collins, Isabella, Kelly, Larson, Long, Lost Pete, Osier, Quartz, and Schofield, Upper Kelly, and Upper Weitas creeks, (Table 4). This is the first year radio-tagged bull trout were documented in the Cayuse and Upper Kelly creek watershed groups. Bull trout within Cold Springs, Larson, Lost Pete, Kelly and Lost Pete watershed groups were comprised of bull trout that remained in the mainstem NFC or Kelly Creek and were never detected in a tributary. Radio-tagged bull trout from these watershed groups may have immigrated into tributaries for a short duration to spawn, but were not detected due to our biweekly flight schedule. The watershed groups Headwaters NFC and Beaver, Cayuse, Collins, Isabella, Osier, Quartz, Upper Kelly, and Upper Weitas creeks were comprised of bull trout that entered tributaries. The Long Creek watershed group consisted of nine radio-tagged bull trout that remained in the Black Canyon section of mainstem NFC; four immigrated into tributaries, two into each Lake and Long creeks. Radio-tagged bull trout from this watershed group may have immigrated into tributaries for a short duration to spawn, but were not detected due to our biweekly flight schedule.

The watershed groups where radio-tagged bull trout were found within the LNF sub-basin were: Middle and Upper LNF, Floodwood and Stony creeks (Table 4). The Floodwood Creek watershed group consisted of eight radio-tagged bull trout and the Stony Creek watershed group consisted of two radio-tagged bull trout (Table 4). The Middle LNF watershed group consisted of 15 radio-tagged bull trout, 13 were detected in the mainstem only and 2 were detected in Foehl Creek (Table 4). Forty bull trout immigrated into the Upper LNF; this represented the highest concentration of radio-tagged bull trout to be located within a watershed group (Table 4). Two of these fish were located in tributaries, one in Lund Creek and one in Rocky Run Creek.

Bull trout remaining in Dworshak Reservoir were separated into three groups: Middle Dworshak Reservoir, NFC, and Upper Dworshak Reservoir. The NFC and Upper Dworshak Reservoir watershed groups consisted of three and a single radio-tagged bull trout respectively (Table 4). The Middle Dworshak Reservoir watershed group consisted of 23 fish, all were acoustic transmitters detected on the Cranberry Creek fixed-site.

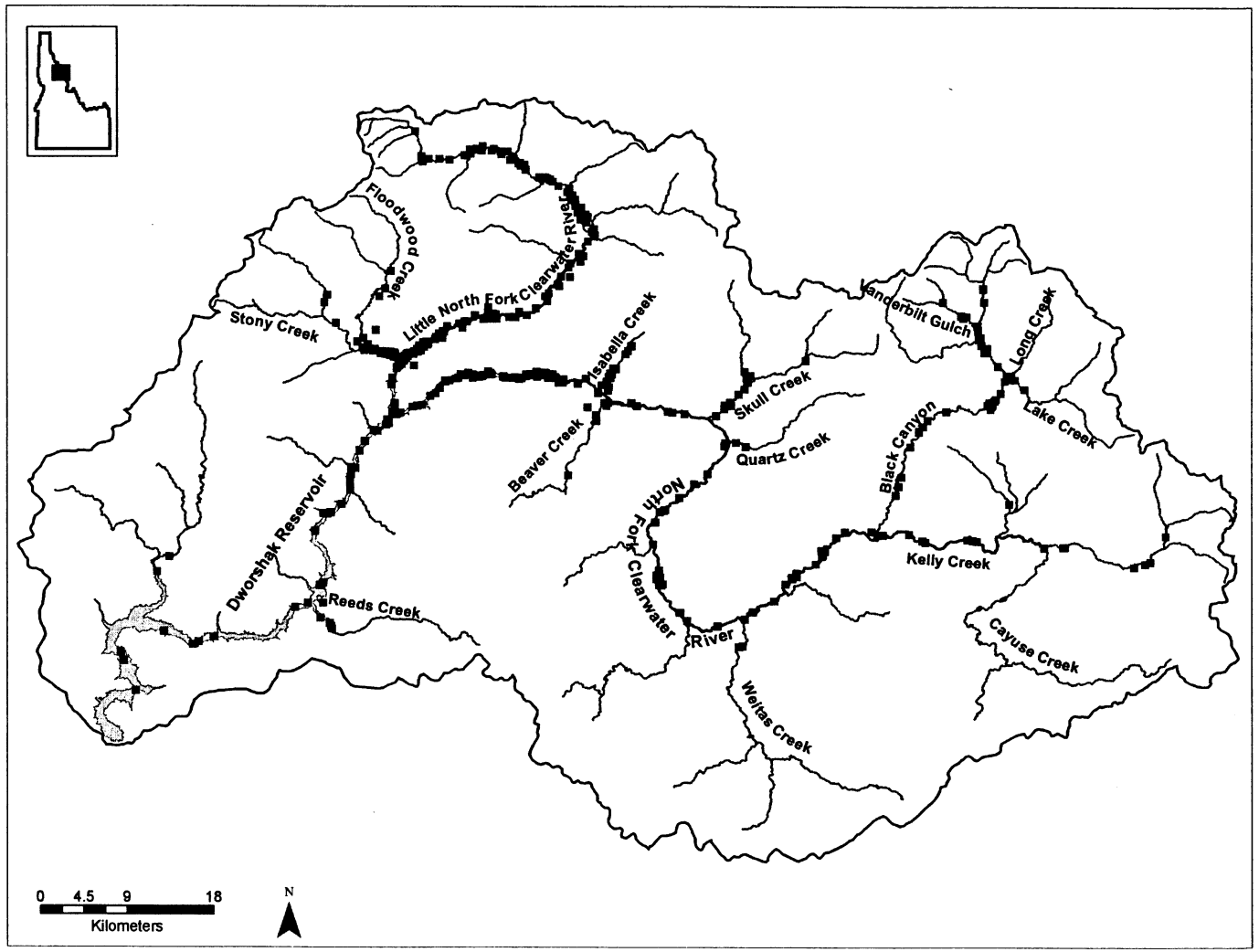

Figure 6. Distribution of all radio and acoustic-tagged bull trout detections during the migration time period, May 1- July 30, 2003, in the North Fork Clearwater River.

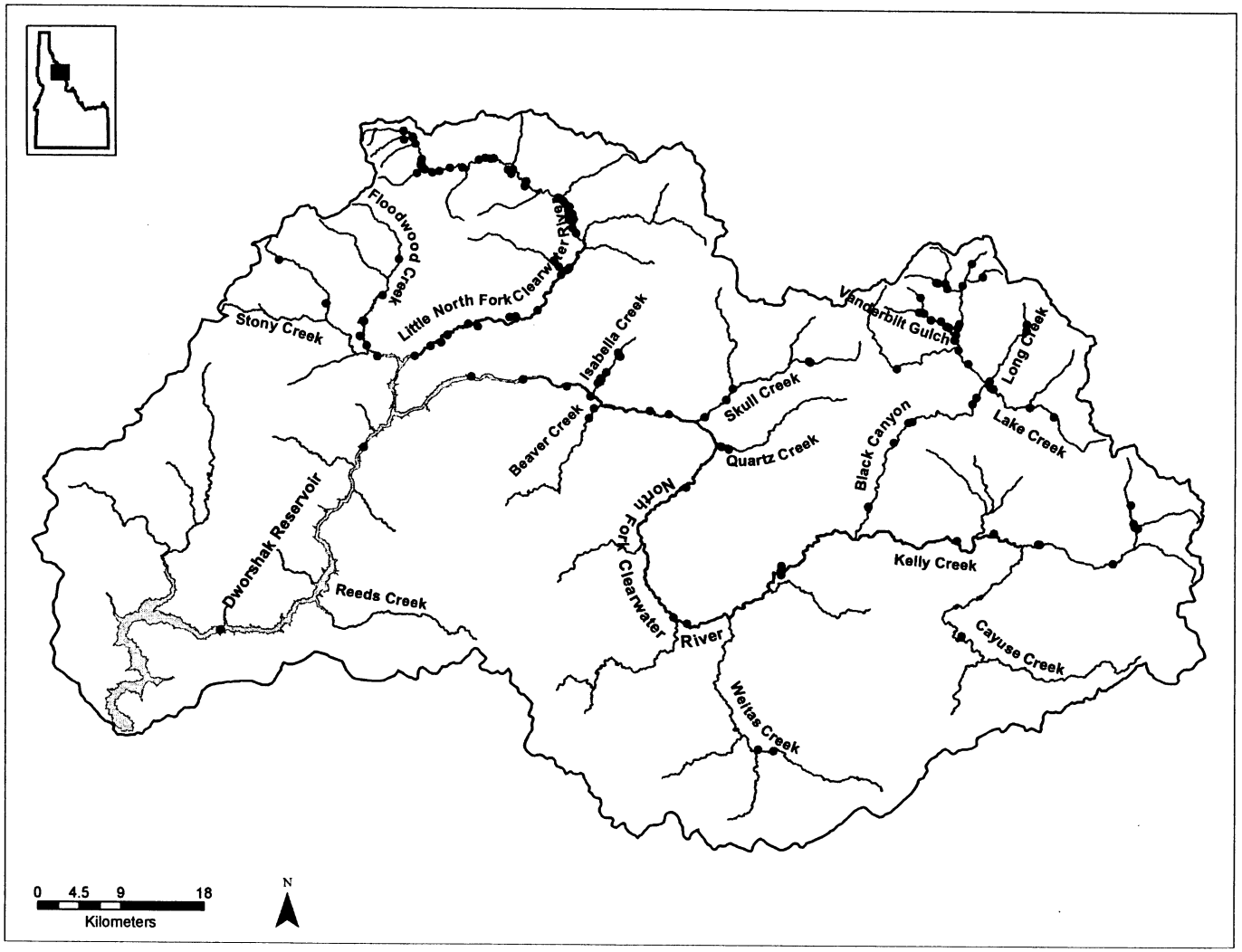

Figure 7. Distribution of all radio and acoustic tagged bull trout detected during the spawning time period, August 15 to October 15, 2003, in the North Fork Clearwater River. Each radio-tagged bull trout is represented only once during this time period for simplification of distribution and numbers.

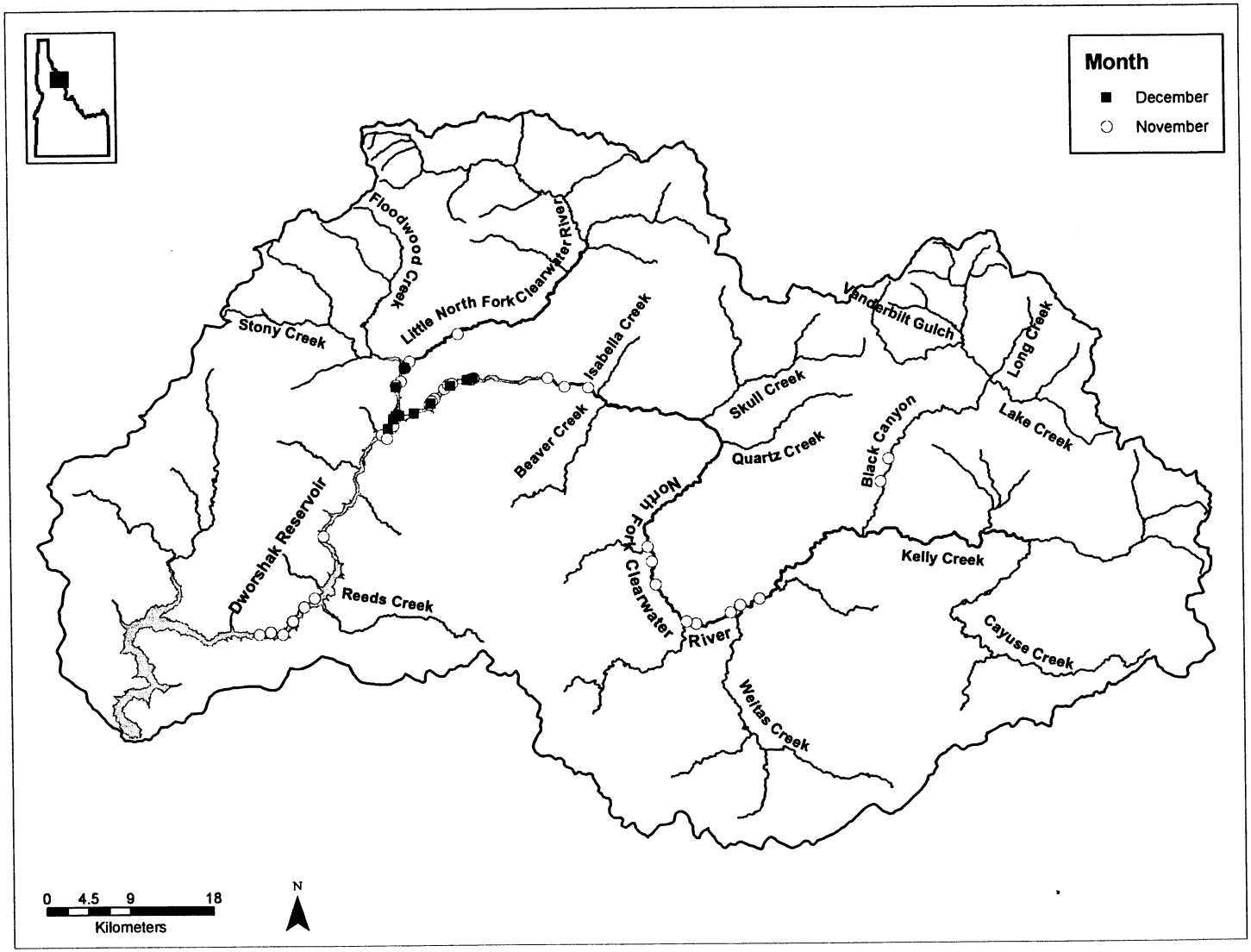

Figure 8. Distribution of all radio and acoustic tagged bull trout detections during the overwintering time period November 1 to December 31, 2002 in the North Fork Clearwater River.

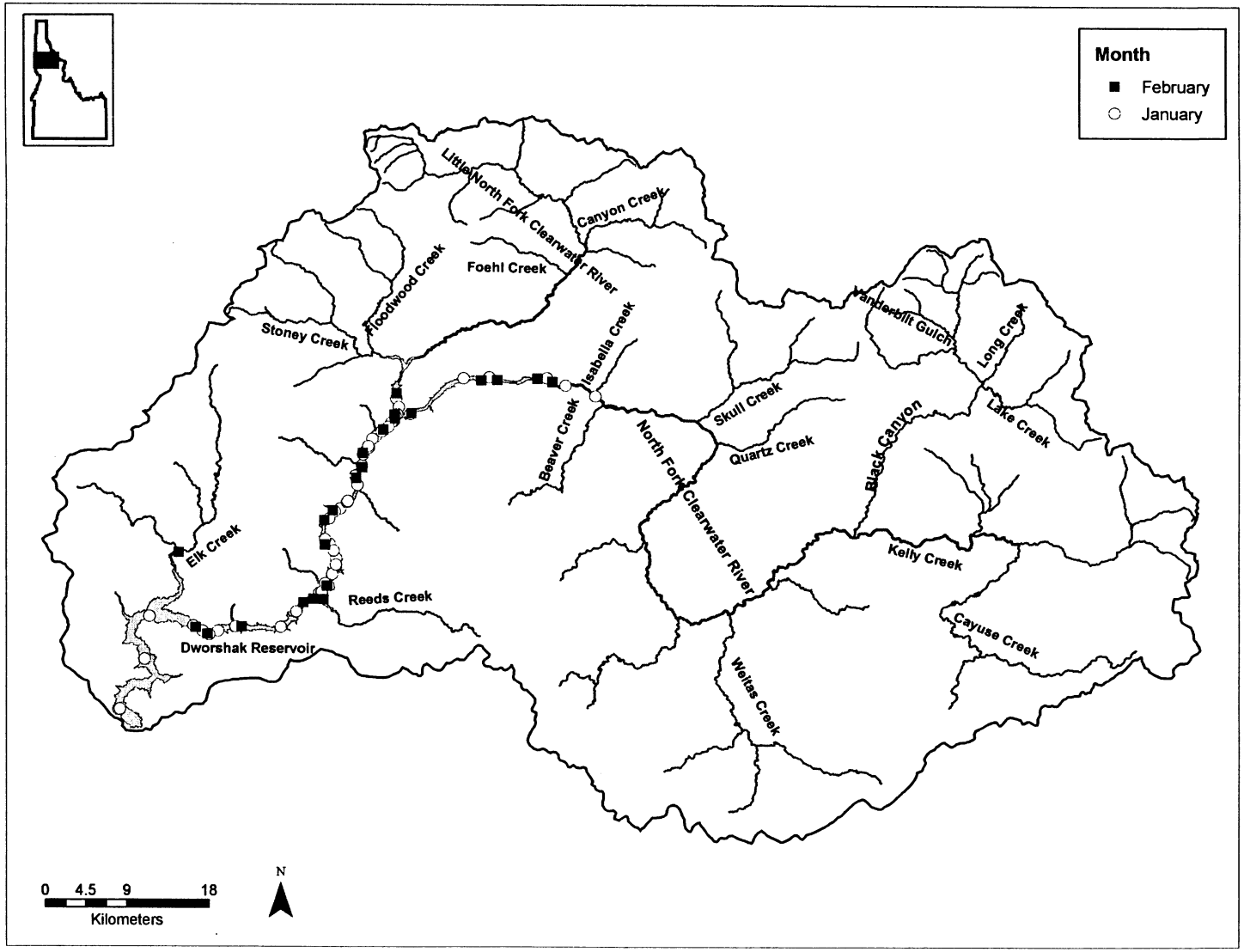

Figure.9. Distribution of all radio and acoustic tagged bull trout detections during the overwintering time period January 1 to February 28, 2003 in the North Fork Clearwater River.

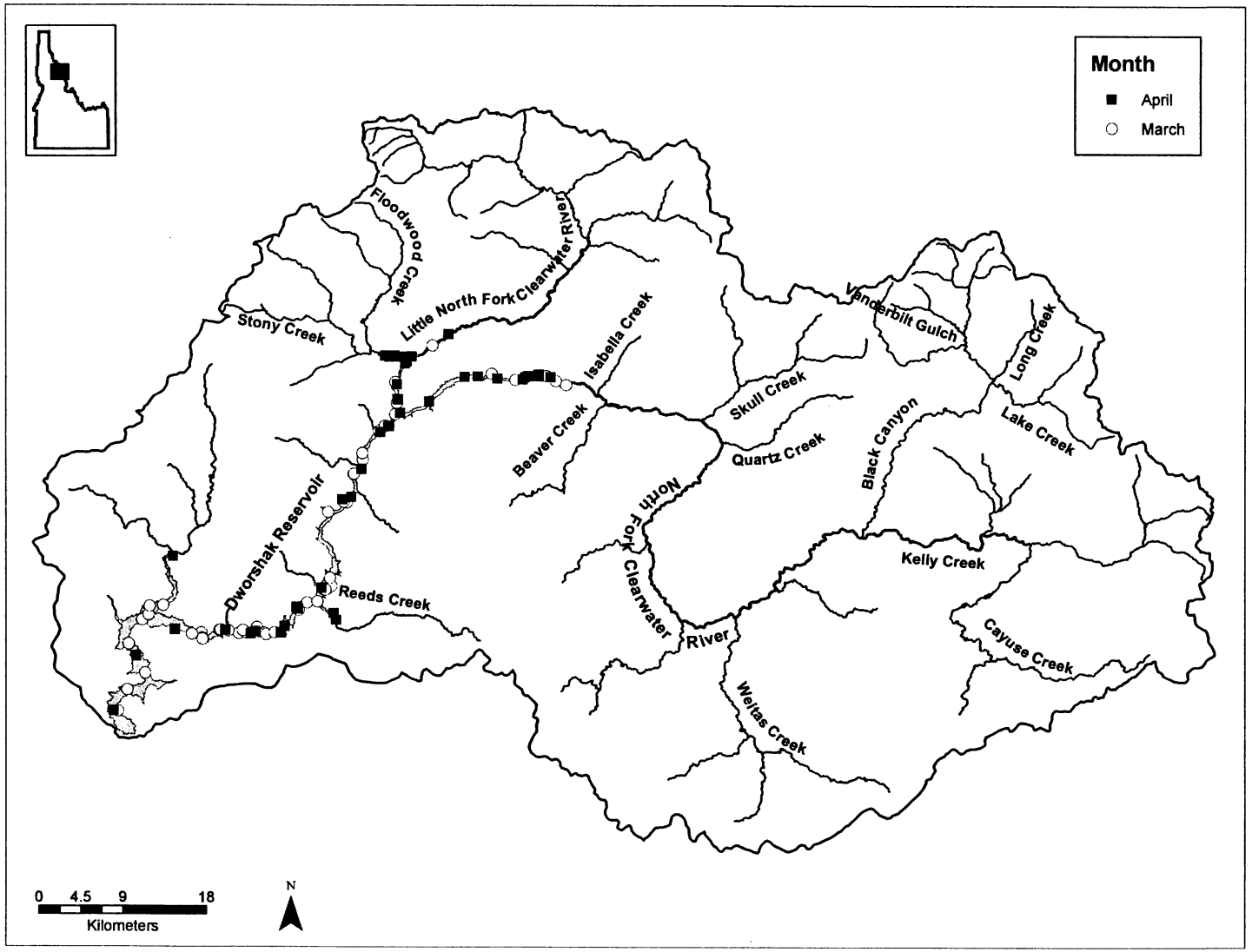

Figure 10. Distribution of all radio and acoustic tagged bull trout detections during the overwintering time period March 1 to April 30, 2003 in the North Fork Clearwater River.

Table 3. The total number of detections of radio and acoustic tagged bull trout during the overwinter time period, separated by month and section.

Section		Month						
		November	December	January	February	March	April	Total
Dworshak Reservoir								
Section 1	Dam to Dent Bridge	0	0	5	3	14	4	26
Section 2	Dent Bridge to Evans Creek	6	0	13	5	25	14	63
Section 3	Evans Creek to Grandad Bridge	11	7	31	12	12	6	79
Section 4	NF Arm	17	10	5	5	5	17	59
Section 5	LNF Arm	20	5	2	1	2	22	52
LNF Riverine		1				1	1	3
NFC Riverine		14		1				15
	Total Detections	69	22	57	26	59	64	297
Detection Type								
Acoustic		20	18	27	6	20	16	107
Radio		49	4	30	20	39	48	190

Table 4. Number of radio and acoustic tagged bull trout detected in each watershed group.

Subbasin	Watershed Group (5th Field HUC)	Number of Bull Trout 2000	Number of Bull Trout 2001	Number of Bull Trout 2002	Number of Bull Trout 2003
NFCR	Beaver Creek	1	1		2
	Cayuse Creek				1
	Cold Springs Creek	1	2	5	5
	Collins Creek		1	3	6
	Headwaters NFCR	3	5	2	21
	Isabella Creek			1	8
	Kelly Creek	2		3	2
	Larson Creek		1		1
	Long Creek	4	6	12	13
	Lost Pete Creek	3	2	2	2
	Osier Creek	1	2	2	
	Quartz Creek		2	1	2
	Schofield Creek		2		2
	Upper Kelly Creek				7
	Upper Weitas Creek	1	1		2
LNF	Canyon Creek		3		
	Floodwood Creek		5	1	8
	Stony Creek		2	2	2
	Middle LNF		7	8	15
	Upper LNF		19	15	40
Dworshak Reservoir	Lower Dworshak Reservoir	1			
	Lower NFCR		3	4	
	Middle Dworshak Reservoir			1	23
	NFC	4	12	4	3
	Upper Dworshak Reservoir		6		1
Unknown Detected at Fixed Site Only		2	3		
Unknown Not Detected After Tagging			26	10	3

Entrainment

Analysis of the spatial and temporal distribution of transmitters throughout the overwintering time period, infers that bull trout are most susceptible to entrainment loss through Dworshak Dam from January to April. Radio and acoustic-tagged bull trout were first detected in the lower reservoir, below the Elk Creek arm, in January. We do not consider fish that are above the Elk Creek arm of the reservoir at risk of entrainment. Tagged bull trout were consistently detected in the lower reservoir from January to April (Figures 9 and 10). By January, tagged fish were detected less than 1 km from Dworshak Dam and some remained in this area until late April (Figures 9 and 10). The distribution of fish in the lower reservoir at this time of year predisposes them to entrainment risk. By the middle of April, discharge from Dworshak Dam can exceed 453 cms (Figure 11). During spring discharge in 2003, we documented a radio-tagged bull trout being entrained through the project. It is uncertain if this fish went through the turbines, regulating outlets, or over the spillway. This bull trout survived entrainment and was detected moving up and down stream in the NFC below the dam and the mainstem Clearwater River. This is the first documentation of a tagged bull trout entrained from the project since this study began in 2000.

Multiple Migrations

Three radio-tagged fish migrated into two different watersheds in 2003. Two fish, 148.48.021 and 148.77.145 left Dworshak Reservoir in late June to early July and moved into Stony and Floodwood creeks (Figure 12 and 13). These fish then left these areas, and moved through Dworshak Reservoir from the middle of July through early August (Figure 12 and 13). They were then detected in the mainstem LNF were it is suspected they spawned (Figure 12 and 13).

Fish 148.76.040 was detected in Skull Creek from 29 June - 21 July 2003 (Figure 14). This fish was then detected at the NFC fixed site on July 27, 2003 returning to the reservoir. Eleven days later on August 7, 2003 this fish was detected in the LNF at approximately rkm 57.8. This fish migrated 83.2 km in eleven days and did not appear to be impeded by water condition or temperatures in the NFC and LNF arms of Dworshak Reservoir.

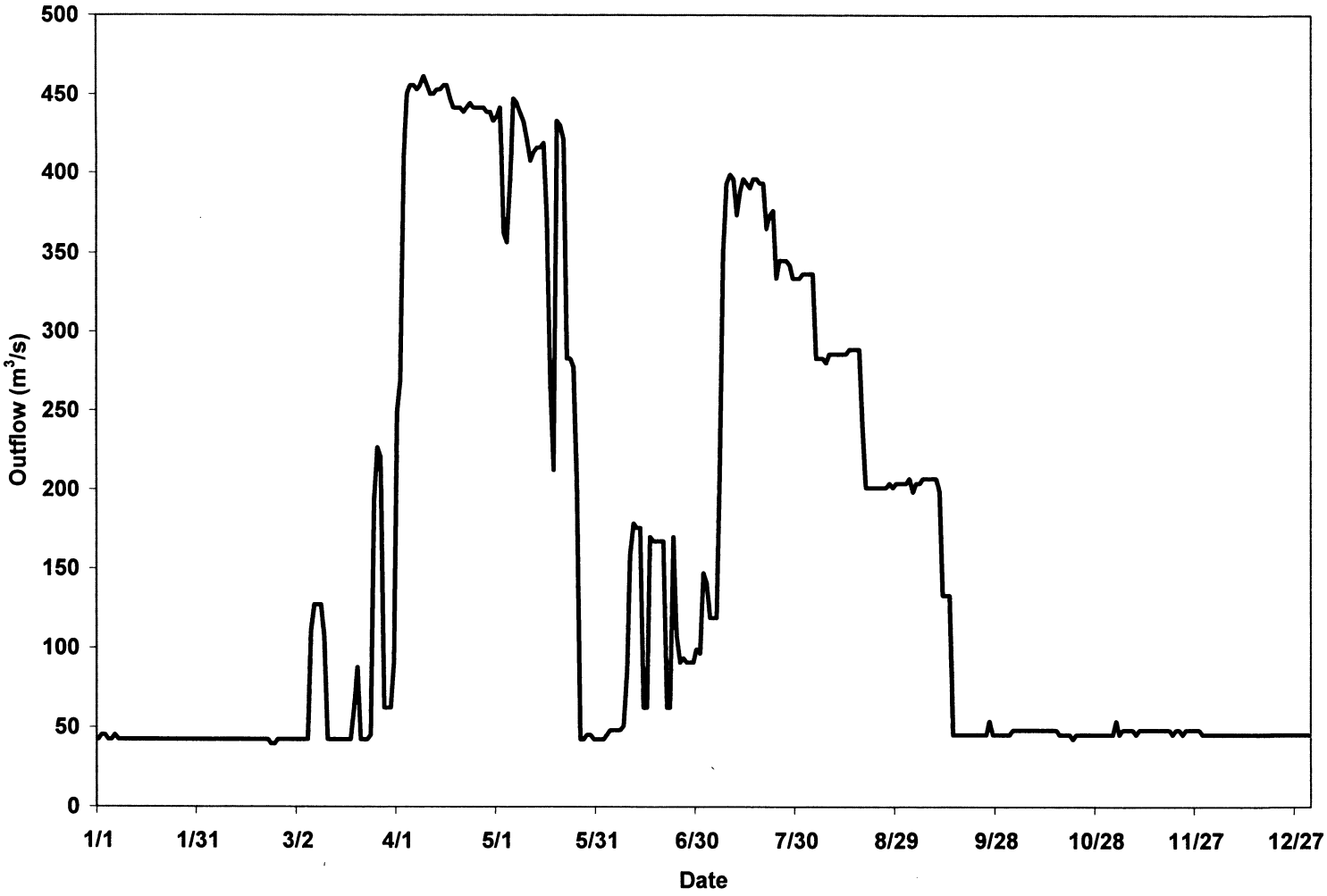

Figure 11. Outflow from Dworshak Dam from January 1 to December 31, 2003. Outflow includes water released from the spillway, release outlets, and turbines.

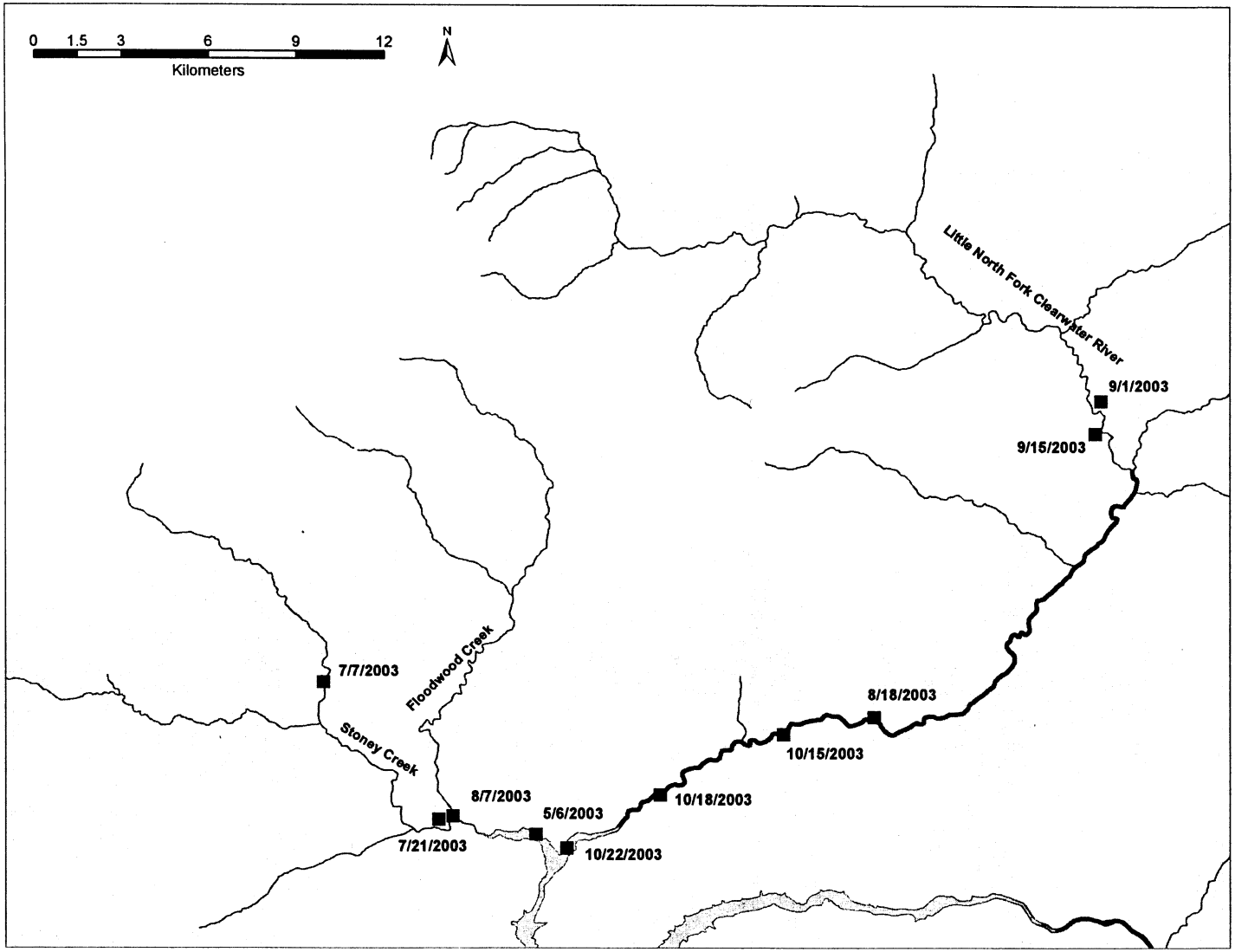

Figure 12. Detection points and dates for radio-tagged bull trout 148.48.021, 2003.

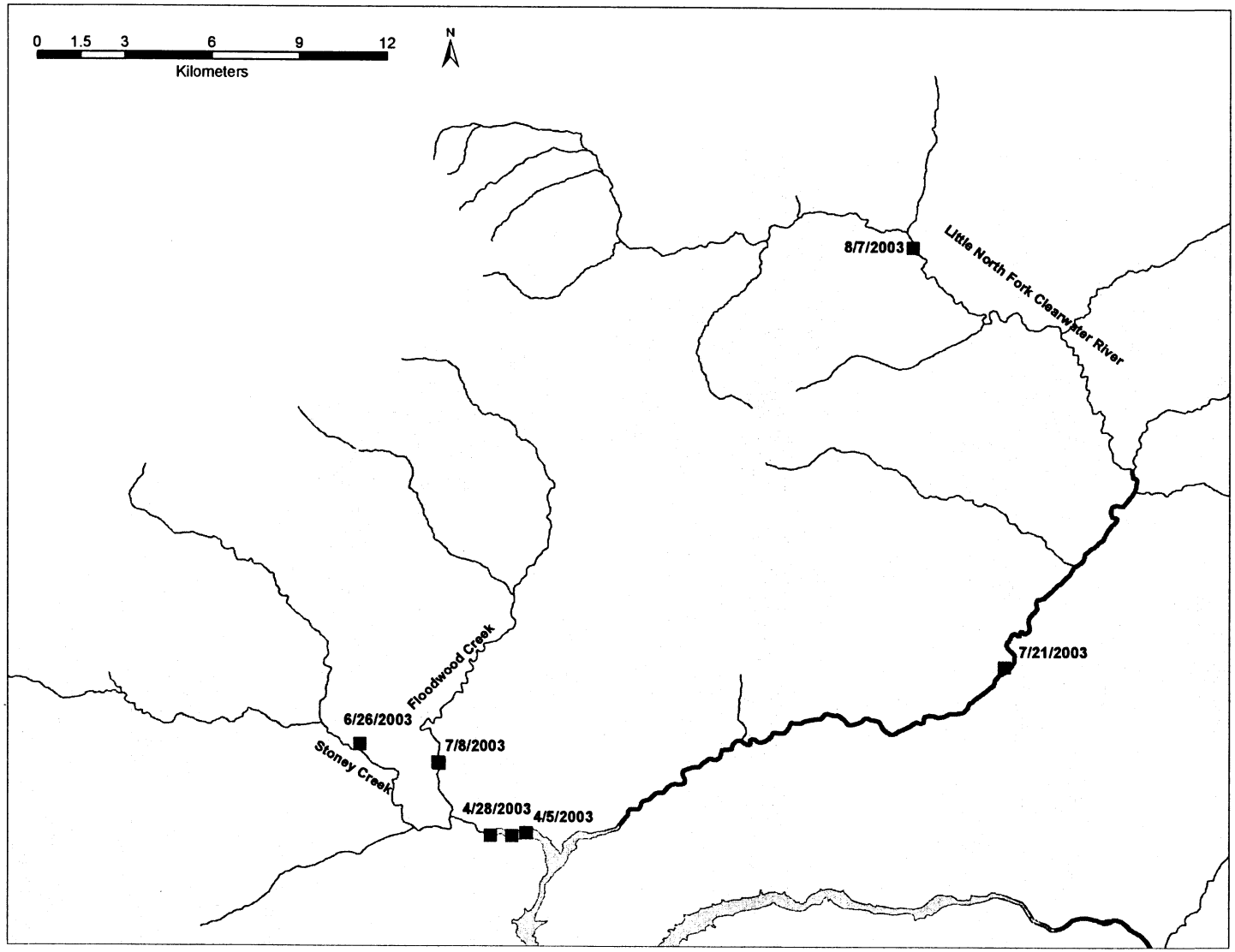

Figure 13. Detection points and dates for radio-tagged bull trout 148.77.145, 2003.

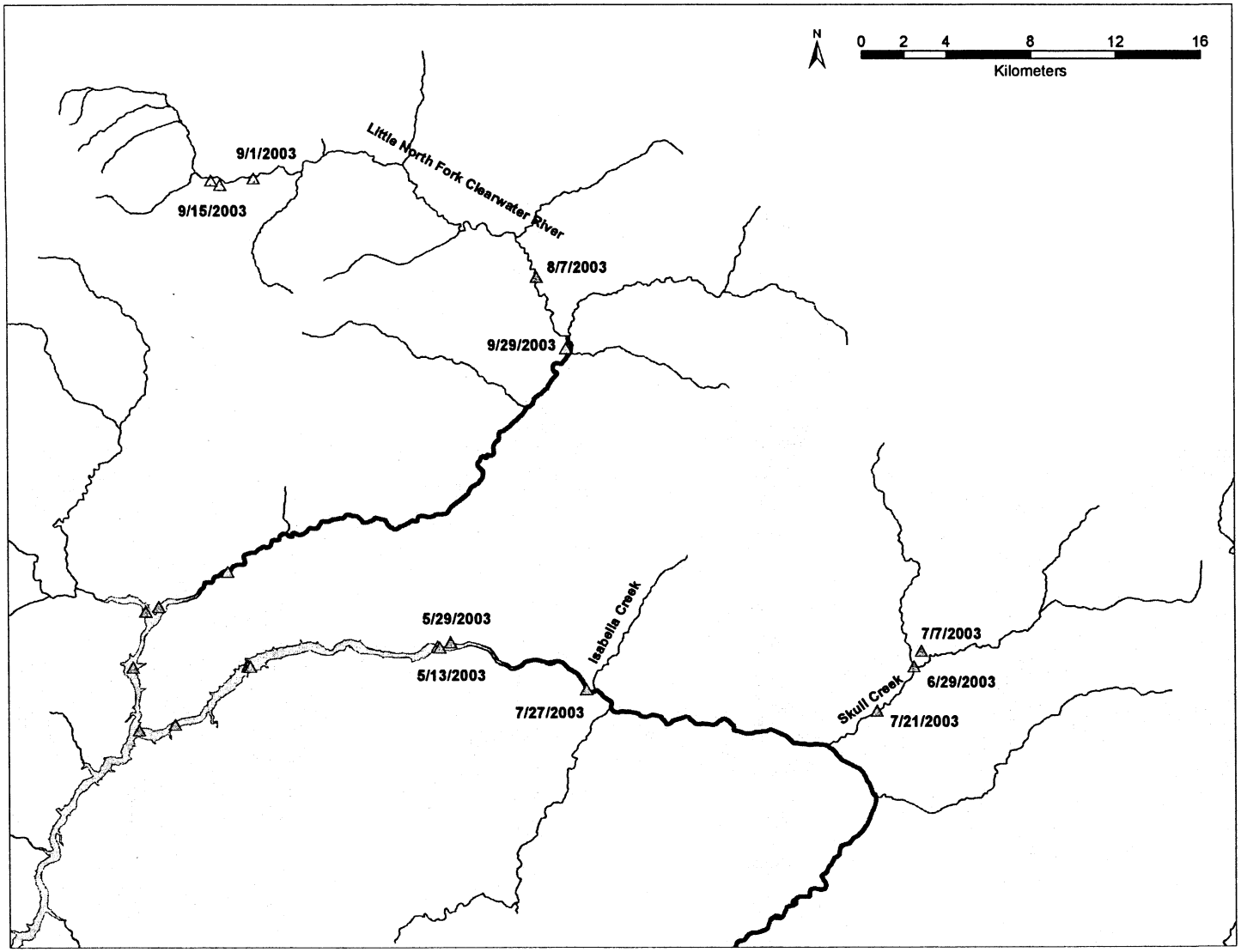

Figure 14. Detection points and dates for radio-tagged bull trout 148.76.040, 2003

Life History Information

Spawning Frequency

Tracking of post-spawning adults in 2002 detected 40 radio-tagged bull trout that retained their radio transmitters and survived through spawning to overwinter in downstream locations. All returned to Dworshak Reservoir and were distributed between rkm 3.1 and rkm 91.9. We were unable to continue tracking 72% (29/40) of the fish that returned to the reservoir beyond June 2003, because the battery in their transmitters expired. We were able to continue to track 11 of the fish radio-tagged in 2002. We documented that 91% (10/11) of the bull trout that spawned in 2002 migrated from Dworshak Reservoir into spawning areas again in 2003 (Table 5). One fish, 149.44.065, returned to the reservoir for overwintering but was entrained through Dworshak Dam in April. It is unknown if this fish attempted to spawn in 2003.

Fish 148.77.145 is suspected to be an alternate year or less frequent spawner. This fish was radio-tagged in 2002 and never detected migrating from Dworshak Reservoir that year. It was subsequently detected migrating from the reservoir into a known spawning area in 2003 (Table 5, Figure 13).

Site Fidelity

Ninety percent (9/10) of the fish believed to be repeat year spawners were detected in the same watersheds in 2003 and 2002 (Table 5). Ten percent (1/10) were detected in different watershed in 2003 compared to 2002. This fish, 148.77.134, migrated into the Cold Springs watershed in 2002 and the Headwaters NFC in 2003 (Table 5). This fish migrated an estimated 334.7 km during this time period. Fish 148.77.136 was documented traveling the longest overall migration distance, 443.0 km, between 2002 and 2003 (Table 5). Sixty percent (6/10) of the repeat spawners returned to the Upper LNF watershed (Table 5).

Sex Composition

Sex was determined on 118 bull trout captured in 2003 (Figure 15). There were 66 females and 52 males detected over the course of sampling, a ratio of 1.27 females per males. There was no significant difference in weekly detections between males and females (Figure 15).

Redd Surveys

Bull trout redd surveys were conducted from September 9 to 21, 2003 in the NFC drainage. In the NFC, the following tributaries were surveyed: Bostonia, Boundary, Goose, Isabella, Lake, Long, Osier, Placer, Pollock, and Swamp creeks and Vanderbilt and Niagara gulches. Isabella and Skull creeks had a high number of kokanee spawning in them and it decreased our ability to correctly identify bull trout redds from kokanee redds in these drainages. In the LNF redd

surveys were conducted on the mainstem upper LNF and Butte, Lost Lake, Little Lost Lake, Lund, and Rocky Run creeks. Redd surveys were also completed on Floodwood and Stony creeks. Seventy-four redds were located within the NFC drainage, with the highest number of redds, 18, observed in Bostonia Creek (Table 6). In the LNF, 48 bull trout redds were observed, with the highest number of redds observed in the upper mainstem LNF above Forest Service road 301(Table 6). There were no redds observed in Lost Lake Creek, Floodwood and Stony creeks.

Survival

One-hundred-thirty radio-tagged bull trout were detected migrating from Dworshak Reservoir in the spring of 2003; four remained in the reservoir throughout the year. Sixty-two percent (83/134) of these fish were detected in the reservoir in the fall or winter of 2003. There were 20 fish that either shed their transmitters during spawning or died from undetermined causes near spawning time. Six fish were detected migrating back downstream after spawning but died, were harvested, or succumbed to predation on their return migration in the mainstem NFC. There were five fish that migrated from the reservoir but did not make it to spawning areas and are suspected to be angling related mortalities. One fish carcass was recovered along the bank. This fish had obviously been captured by an angler and filleted, as the only part of the fish left was the head and skeleton. It is unknown what happen to 16 fish as they were not detected after spawning in the reservoir or mainstem NFC or LNF. A transmitter was collected from an angler's tackle box. He stated that he found the transmitter on the bank. It is believed that if this transmitter had not been detected in the angler's tackle box it would have been taken home with the angler. This would have removed the transmitter from the study area. It is unknown how frequently this occurs but does shed light on a possible location of missing transmitters. The second possibility is that a predator or human damaged the transmitters.

Growth

The average growth rate for all fish recaptured and PIT-tag identified was calculated at 0.115 mm/day. After visual inspection of the data it appeared that fish of smaller initial capture length grew at a different rate than larger fish. Therefore, recaptures were grouped in 75 mm grouping starting at 300 mm based on initial capture length. The mean growth rate for each group was 0.157 mm/day (300 – 374 mm), 0.117 mm/day (375 – 424 mm), 0.080 mm/day (425 – 499 mm), 0.122 mm/day (500 – 574 mm), and 0.037 mm/day (575 – 650 mm) (Figure 16).

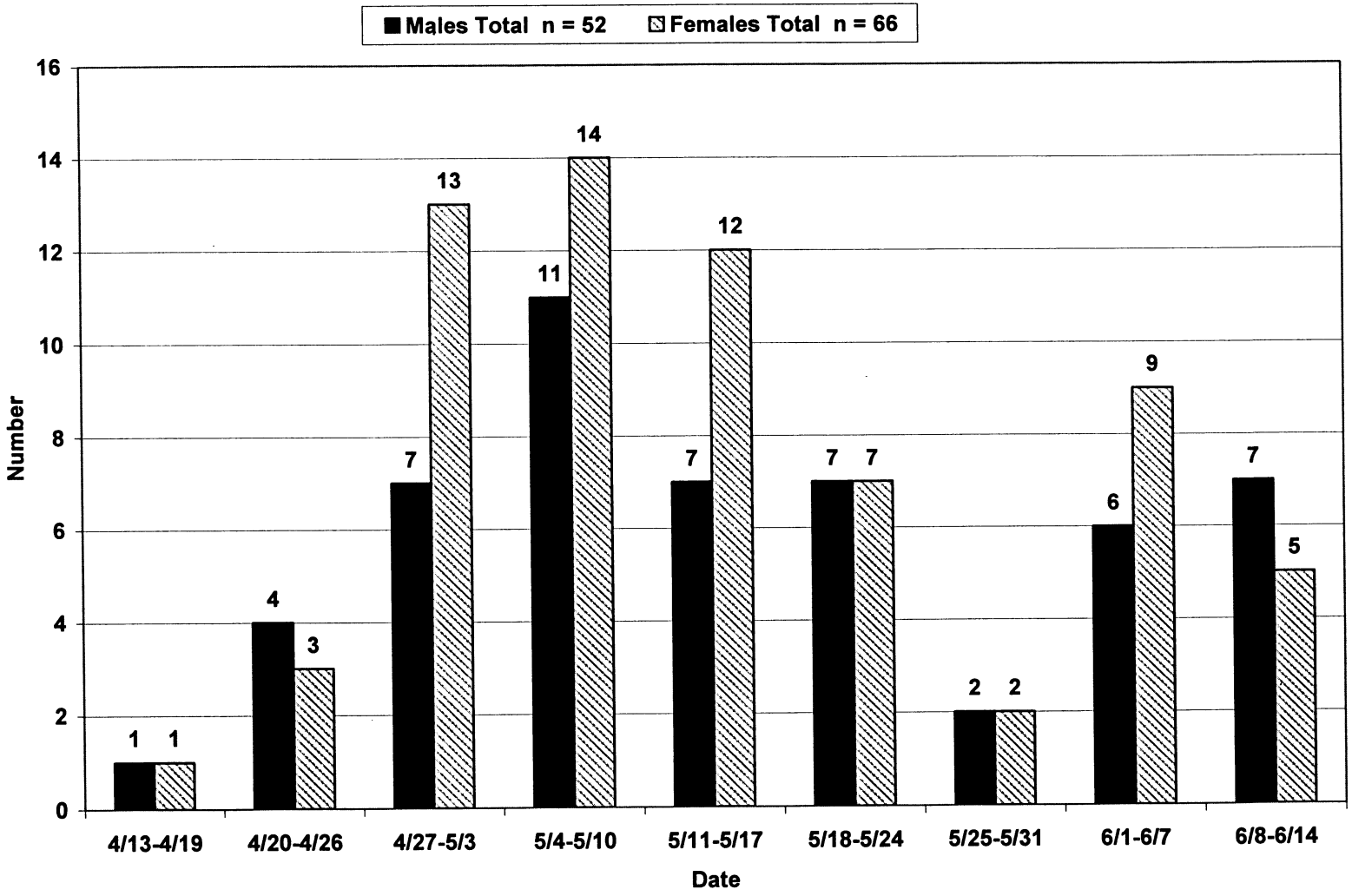

Figure 15. Weekly sex composition of bull trout captured and radio-tagged in the North Fork Clearwater River, 2003

Table 5. Watershed group, migration timing and total migration distance of bull trout radio-tagged in 2002 and tracked in 2003.

Bull Trout Radio Number (Frequency -Code)	Tagging Subgroup	Watershed Group 2002	Date past fixed site upstream	Date located at maximum migration point[a]	Date past fixed site downstream 2002	Migration distance from tagging location 2002 (km)[a]	Downstream migration distance 2002-2003 (km)	Watershed Group 2003	Date located at maximum migration point[b]	Total Migration Distance in 2003 (km)	Alternate or Repeat Year Spawner	Total Migration Distance 2002-2003 (km)
148.77.145	NFC	NFCR		19-Aug-02		20.2	89.8	Upper LNF	7-Aug-03	83.3	Alternate	193.3
148.77.134	NFC	Cold Springs		19-Aug-02		88.64	108.2	Long Creek	7-Aug-03	137.8	Repeat	334.7
148.77.136	NFC	Long Creek	11-Jun-02	19-Aug-02		91.7	163.4	Headwaters NFC	17-Aug-03	187.9	Repeat	443.0
148.77.137	LNF	Upper LNF	18-Jun-02	3-Sep-02		77.3	85.5	Upper LNF	17-Aug-03	82.3	Repeat	243.1
148.77.139	LNF	Upper LNF		6-Aug-02		61.1	107.1	Upper LNF	21-Jul-03	106.2	Repeat	274.4
148.77.140	LNF	Upper LNF	21-Jun-02	19-Sep-02	30-Sep-02	69.5	50.4	Upper LNF	1-Sep-03	53.8	Repeat	173.7
148.77.141	LNF	Upper LNF	11-Jun-02	3-Sep-02	12-Oct-02	64	96.1	Upper LNF	15-Oct-03	98.8	Repeat	258.8
148.77.042	LNF	Upper LNF	13-Jun-02	3-Sep-02	29-Sep-02	70.9	101.4	Upper LNF	1-Sep-03	102.4	Repeat	283.3
149.44.063	LNF	Upper LNF	30-Jun-02	3-Sep-02	29-Sep-02	79.5	71.3	Upper LNF	17-Aug-03	69.1	Repeat	219.9
149.44.064	BFC	Headwaters NFC	13-Jun-02	19-Sep-02		152.7	147.9	Headwaters NFC	17-Aug-03	124.4	Repeat	425.0
149.44.069	BFC	Stony Creek	22-Jul-02	9-Aug-02	30-Sep-02	20.6	16.8	Stony Creek	1-Sep-03	49.3	Repeat	86.7

[a] A negative number indicates that the bull trout moved downstream from its tagging location.

[b] Date located at maximum number migration is within 15 days of actual date due to flight schedule.

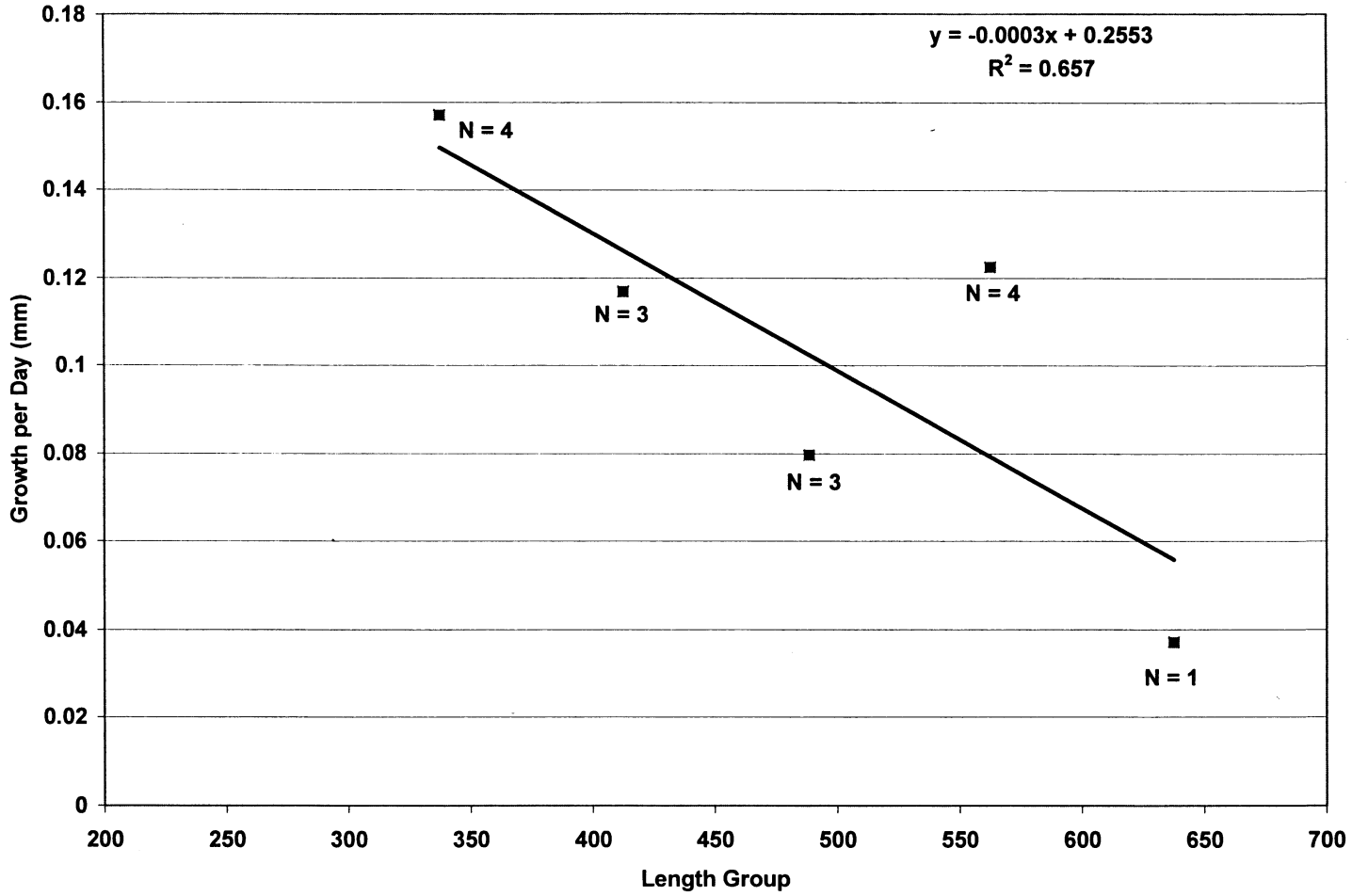

Figure 16. The average growth/day of fish recaptured and PIT tag identified. Recaptured fish are separated into 75 mm groups starting at 300 mm.

Table 6. Number of redds observed in each survey area, 2000-2003. In years where the survey was not completed, they are noted as NA.

Drainage	Stream	2003	2002	2001	2000
North Fork Clearwater River					
	Black Canyon	NA	1	NA	NA
	Bostonia Creek	18	1	NA	NA
	Boundary Creek	2	NA	NA	NA
	Goose Creek	2	0	1	NA
	Isabella Creek	1	1	NA	NA
	Lake Creek	14	20	7	19
	Long Creek	0	5	NA	NA
	Niagara Gulch	10	6	0	2
	Osier Creek	0	2	0	3
	Placer Creek	NA	4	0	3
	Pollock Creek	1	NA	NA	NA
	Quartz Creek	0	0	4	NA
	Skull Creek	6	0	NA	NA
	Swamp Creek	0	1	0	2
	Upper NF	7	NA	NA	NA
	Vanderbilt Gulch	13	18	24	NA
	Weitas Creek	NA	NA	NA	1
Total Redds Observed		74	59	36	30
Little North Fork Clearwater River					
	FS Road 1268 - FS Road 301	9	NA	NA	NA
	301 to Lund	4	15	28	NA
	Butte Creek	0	2	5	NA
	Floodwood Creek	0	4	NA	NA
	Glover Creek	1	NA	NA	NA
	Little Lost Lake Creek	7	7	0	NA
	Lost Lake Creek - Headwaters	6	5	1	5
	Lund - Lost Lake Creek	7	5	12	8
	Lund Creek	8	10	5	NA
	Rocky Run Creek	1	6	NA	NA
	Rutledge Creek	1	NA	NA	NA
	Stony Creek	0	4	NA	NA
	Buck Creek	5	NA	NA	NA
Total Redds Observed		**49**	**58**	**51**	**13**

Relative Abundance /Population Estimate

Relative abundance of bull trout was calculated for populations in 23 different watersheds including Beaver, Bostonia, Foehl, Floodwood, Glover, Goose, Isabella, Kelly, Lake, Long, Little Lost Lake, Moose, Placer, Quartz, Rutledge, Skull, and Weitas creeks, and Vanderbilt and Niagara gulches, and the mainstem NFC. A total of 113 transects were snorkeled, bull trout densities per transect ranged from 0.00 – 3.13 bull trout/100m^2 (Table 7, Appendix A Table 4).

The population estimate for adult bull trout in areas where known spawning aggregates occur was 1,587 (+/- 448.1).

DISCUSSION

Migration and Distribution

Prior years of bull trout telemetry studies in Dworshak Reservoir relied solely on radio tags. Effective tracking and accurate descriptions of bull trout behavior was compromised because of the physical depth related limitations of radio tags. We implanted bull trout with acoustic transmitters in the fall of 2003 to improve our ability to accurately document their distribution and migration patterns in Dworshak Reservoir. Utilization of acoustic transmitters was effective in increasing the number of bull trout detections and ultimately did result in more accurate descriptions of migration patterns, and temporal and spatial distribution throughout Dworshak Reservoir. Prior to 2003 we did not detect bull trout in the forebay area of Dworshak Dam (Schiff and Schriever 2004). We suspected bull trout inhabited the forebay area but were located at depths that precluded detection. Now bull trout have been identified utilizing the forebay area from January through April.

During the overwintering time period bull trout have been distributed throughout Dworshak Reservoir, from the slack water interface to the dam (Figures 6, 7, 8, 9, and 10). However, the majority of detections are concentrated between Dent and Grandad bridges. In prior years, the majority of detections were also between these two bridges (Schiff and Schriever 2004). Although fish are located in the forebay area, the majority are not. The spatial distribution pattern of the majority of fish does not include the forebay area; the area fish are most susceptible to entrainment. Therefore, we presume the majority of the population has a low risk of entrainment.

Radio-tagged bull trout were documented in a new overwintering area. We documented bull trout using the Elk Creek arm of Dworshak Reservoir from February to April. This represents the first time bull trout have been documented in this location during the overwinter time period. Previously bull trout had been captured in this location during May.

The Bull Trout Problem Assessment speculates that temperatures and habitat conditions in Dworshak Reservoir during July and August could impede or prevent bull trout movements (CBBTTAT 1998). At this time of year the reservoir is thermally stratified and water temperatures in the epilimnion can exceed bull trout lethal limits. These water temperatures have the potential to limit or prevent bull trout migrations. Additionally, summer water

withdrawal from the project runs from July through September. During this time, the reservoir's pool elevation drops an average of 0.3 m per day and the elevation varies from 488 m (full pool) to 472 m. When the reservoir is at full pool, fish encounter slack water that is thermally stratified. As the pool elevation recedes, an additional four miles of riverine habitat that was reservoir is exposed. This newly exposed surface is unstable and easily eroded because there is no stream bank vegetation. Also, water temperatures increase rapidly without canopy cover. Although the above water and habitat conditions existed in 2003, they did not limit bull trout movements. Fish 148.76.040, 148.48.021, 148.77.145 were detected moving through Dworshak Reservoir from mid-July through early August. This is when these poor and impeding water and habitat conditions were speculated to limit bull trout movement.

Entrainment

In 2003, the first radio-tagged fish was entrained through Dworshak Dam. This fish was lost during the overwintering time period. Sixty-two radio-tagged fish were in the reservoir during this time period; all had the potential to be entrained. However, only a single fish, or 1.6% of the radio-tagged fish were entrained. The entrained fish was first detected below Dworshak Dam after peak water discharges from the project. The discharges ranged from 371-m^3/s to 453-m^3/s and lasted 44 days. This fish was located above the dam prior to this water discharge event. Therefore, we believe this fish was flushed through the project during this event. Fish were detected in the forebay area during lower discharges; however, fish were not lost through the dam. We speculate high discharges from Dworshak Dam are associated with bull trout entrainment.

Currently, there is not a total population estimate for bull trout in the reservoir; therefore we cannot extrapolate the number of adult fish lost. Additionally, all bull trout with transmitters in the lower section of the reservoir were greater than 350 mm TL; these are adult-sized fish. Currently, we do not know the distribution and reservoir usage patterns of sub-adult and juvenile fish. They were documented to remain in the reservoir throughout the year (Schiff and Schriever 2004); consequently they may more frequently inhabit the forebay area. Additionally, smaller, juvenile-sized, fish have lower critical swimming velocities compared to adult-sized fish (Mesa et. al. 2004). Therefore, lower water discharge velocities from the dam that do not affect adult fish may cause juvenile fish to be entrained. Further research will be needed to determine the total number of bull trout entrained on an annual basis and its potential population level effect. Section II of this report will focus on research completed below Dworshak Dam in the lower NFC and mainstem Clearwater River down to Lewiston, Idaho.

Life History Characteristics

Alternate and repeat year spawning is known to occur in bull trout populations. We documented 91% of the radio-tagged bull trout that survived spawning and returned to Dworshak Reservoir in 2002 returned to spawning areas in 2003. This is the highest estimate for repeat spawning we have detected. The previous estimates were 50% and 74% in 2001 and 2002, respectively, (Schiff and Schriever 2003, Schiff and Schriever 2004); however, sample sizes were small, 6 and 19, which may bias the estimates. The mean for repeat spawning in all years is 72% (26/36). his average estimate is represented within the range of 66 - 80% documented by Elle et al. (1994) in Rapid River, Idaho.

Table 7. The mean densities of bull trout observed while snorkeling in the North Fork Clearwater River, July – August 2003.

	Beaver Creek	Bostonia Creek	Black Canyon	Foehl Creek	Floodwood Creek	Glover Creek	Goose Creek	Isabella Creek	Kelly Creek	Lake Creek	LNF	Little Lost Lake Creek
Mean density of bull trout per 100 m^2	0.16	0.88	0.14	0.27	0.08	0.16	0.66	0.18	0.19	0.35	0.28	3.00
Median	0.20	0.88	0.20	0.27	0.08	0.16	0.66	0.18	0.10	0.17	0.27	3.00
Standard Deviation	0.14	0.36	0.10		0.05			0.12	0.26	0.51	0.22	
Sample Variance	0.02	0.13	0.01		0.00			0.01	0.07	0.26	0.05	
Minimum	0.00	0.62	0.02	0.27	0.00	0.16	0.66	0.00	0.00	0.00	0.00	3.00
Maximum	0.27	1.13	0.25	0.27	0.15	0.16	0.66	0.37	0.71	1.09	0.78	3.00
Sample Size	3	2	7	1	5	1	1	7	6	4	27	1

	Long Creek	Niagara Gulch	NFC above Cedars	NFC above Vanderbilt Gulch	Moose Creek	Placer Creek	Quartz Creek	Rutledge Creek	Skull Creek	Vanderbilt Gulch	Weitas Creek
Mean density of bull trout per 100 m^2	0.59	1.06	0.10	2.41	0.13	2.16	0.06	0.30	0.19	0.32	0.00
Median	0.28	1.30	0.08	2.41	0.13	2.16	0.06	0.30	0.07	0.24	0.00
Standard Deviation	0.80	0.96	0.11	1.02			0.06	0.14	0.40	0.33	0.00
Sample Variance	0.64	0.93	0.01	1.04			0.00	0.02	0.16	0.11	0.00
Minimum	0.00	0.00	0.00	1.68	0.13	2.16	0.01	0.20	0.00	0.00	0.00
Maximum	1.50	1.88	0.33	3.13	0.13	2.16	0.10	0.39	1.38	0.81	0.00
Sample Size	3	3	13	2	1	1	2	2	11	6	4

The proportion of the spawning population displaying spawning site fidelity varies between years. Repeat-year spawners displaying site fidelity increased from 46% in 2002 to 90% in 2003 (Schiff and Schriever 2004). These differences were observed throughout the entire study area and were not stream or tributary specific. Factors contributing to these observed differences are therefore presumed to occur at the watershed scale. Obvious basin wide environmental factors include but are not limited to, stream flow and water temperature. We identified small annual variations in mean-daily stream discharge and water temperatures that are speculated to contribute to observed differences in site fidelity. Stream temperature (measured at the USGS Canyon Ranger Station gauge) during the time period May 20 to August 31 was warmer in 2003 than 2002 (Figure 17). The temperatures in 2002 ranged from 5°C – 19.5°C, those in 2003 were from 7.4°C – 20.9°C (Figure 17). The warmer water temperatures coincided with lower water flows (measured at the USGS Canyon Ranger Station gauge). In 2002, when temperatures were cooler there was greater water discharge (Figure 18). In 2003, when temperatures were higher discharge was lower (Figure 18). At higher discharges, we assume there would be more available habitat; therefore, lower spawning site fidelity, fewer fish returning to the same spawning area. Conversely, when discharge is low and temperatures high, there is high spawning site fidelity. This theory will be further substantiated in 2004.

Population Estimate

The 2002 population estimate was recalculated using the methods described and used in 2003 to allow comparison between years. The recalculated estimate is 1,057 (+/- 408) adult bull trout in known pre-spawning aggregate areas. The area surveyed in 2002 and 2003 was 803 km and 1,506 km, respectively. In 2003, the estimate was greater in total numbers, 1,563 adult bull trout, however nearly twice as much area was surveyed. Additional years of monitoring will be required to determine if this population is increasing, decreasing or remaining constant over time in a consistent area. To more accurately determine the total population size, additional effort is going to be required to determine bull trout habitat preference during pre-spawn aggregation and the amount and availability of these habitat types and areas in the watershed. By adding habitat data we should be able to more accurately provide a total metapopulation estimate.

Size Structure

The size structure of bull trout captured between all years increased in 2003. The majority of fish sampled from 2000 to 2002 were between 300 – 399 mm (Figure 19). In 2003, 42% of the fish were between 400 – 499 mm and an additional 21% between 500 – 599 mm (Figure 19). These two groups accounted for 63% of the fish captured compared to a maximum of 39% in previous years. Currently, we are not certain if the increase in size structure is indicative of a change in the population structure or sampling bias. The same or similar areas, timing and duration were surveyed each year. The only differences were in 2003, more gillnets were used and, at times, larger lures. Bias should have been reduced by using standard survey gill nets. Therefore, it should have selected a representative sample of the population. Consequently, the occurrence of more large fish represents a natural increase in the population size structure. It is not uncommon for bull trout to increase in size following the closure of a sport fishery. Bull trout have a high catchability rate, a slow growth rate and mature relatively late. This renders

adults susceptible to a higher mortality even at low harvest rates. Therefore, even if bull trout harvest, and associated mortality rates, were low during the sport harvest, the population would be suppressed at some level. After closure of the sport harvest there would be a decrease in the mortality rate related to the reduction in angler harvest. Subsequently, the bull trout population would increase following reductions in mortality rates. The spawners in 1995 and the following years would have had higher survival rates because of reduced angling mortality, and subsequently there would have been a greater number of young produced. This is assuming that spawning habitat and food are not limiting factors and juvenile recruitment is directly related to the number of spawning adults. It has been nine years since the closure of the bull trout sport fishery in Idaho. Bull trout reach maturity between ages 4 – 9 (Shepard et al. 1984, Pratt 1985). Prior years results have documented that bull trout in Dworshak Reservoir are not attempting spawning migrations until at least age 6 (Schriever and Schiff 2002). The first spawners from the 1995 year class, assuming they first mature at age 6, would have been in 2001. In 2003, multiple year classes have reached maturity since the sport harvest closure. Additionally, there is a proportion of the population returning for their second or more spawning event. These older, larger fish are now more prevalent in the population, resulting in an increase in the detected number of larger sized individuals. This bull trout population growth will theoretically stabilize if mortality, survival and carrying capacity reach a new equilibrium point.

In 2003, we detected the first fish to be entrained through Dworshak Dam. Additional research in the reservoir and the lower Clearwater River will be required to determine impacts on bull trout in the drainage. Also, future efforts will be directed at determining an annual bull trout population estimate for all of Dworshak Reservoir.

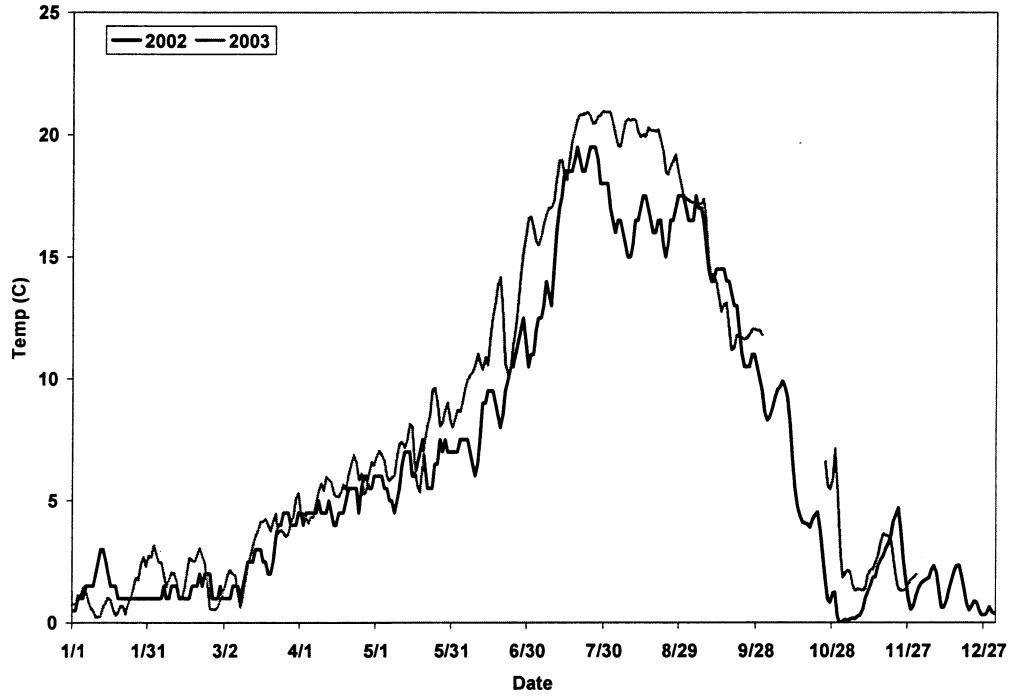

Figure 17. The mean-daily water temperature (°C) for the North Fork Clearwater River at the USGS gauging station number 13340600.

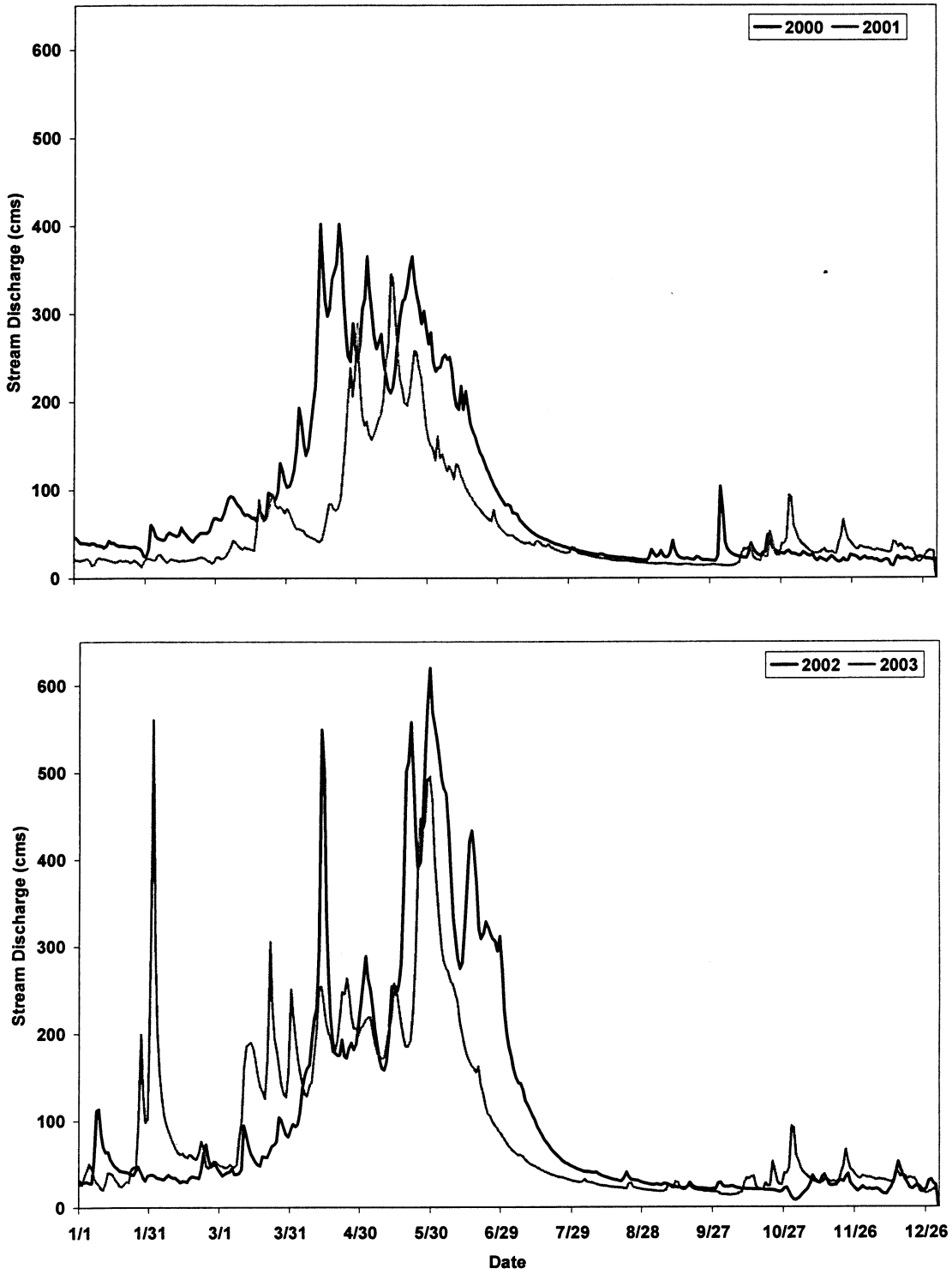

Figure 18. The mean-daily water discharge for the North Fork Clearwater River at the USGS gauging station number 13340600.

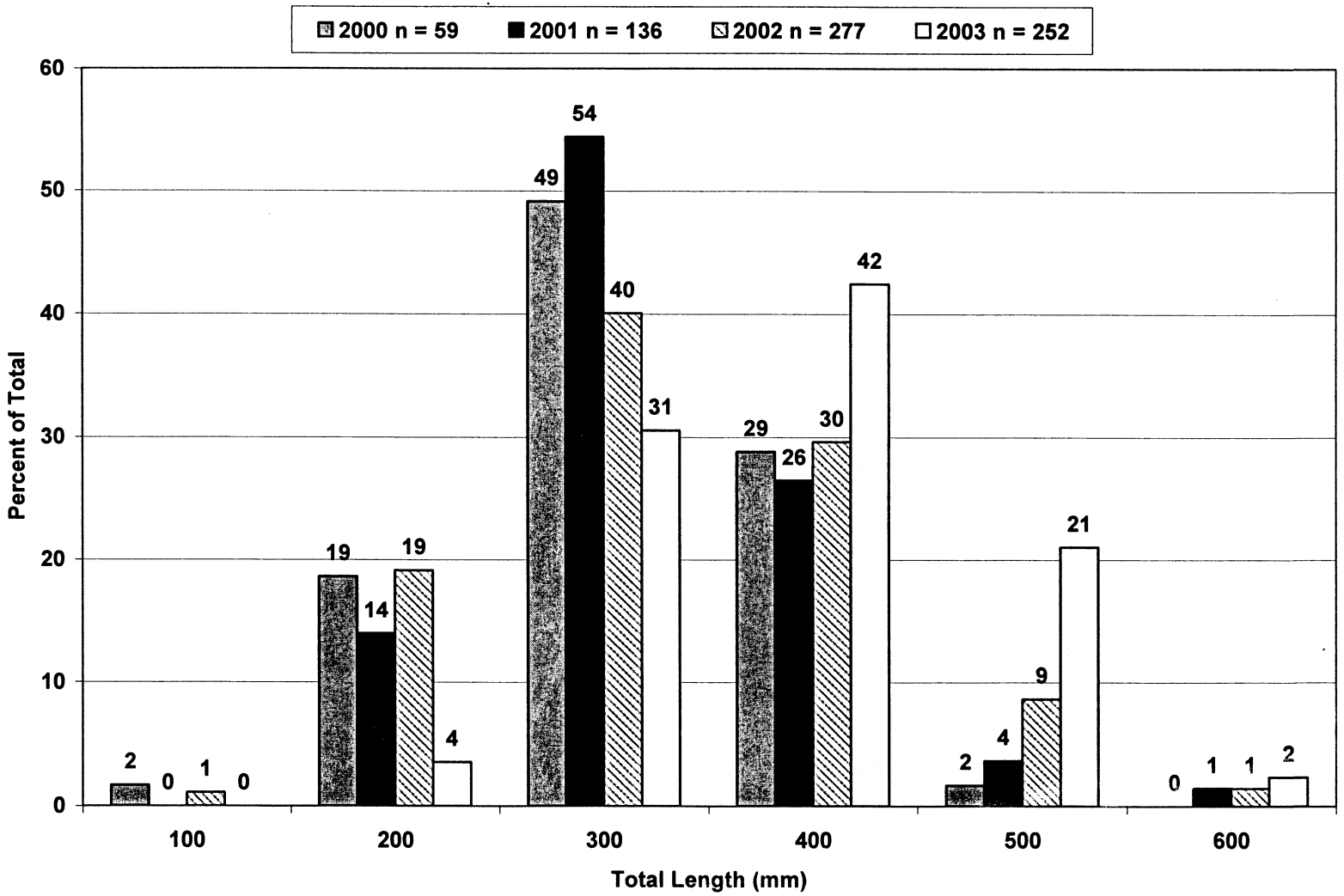

Figure 19. Percent of bull trout captured in each 100 mm grouping from Dworshak Reservoir, 2000 – 2003.

PART II: BULL TROUT NORTH FORK CLEARWATER RIVER BELOW DWORSHAK DAM

INTRODUCTION

Bull trout studies conducted in Dworshak Reservoir and the NFC have documented fish being entrained through Dworshak Dam (Schiff and Schriever 2004). After fish were documented being entrained Idaho Department of Fish and Game (Department) began studying the bull trout found in the North Fork Clearwater River below Dworshak Dam (NFBD) and the lower Clearwater River (CLW).

OBJECTIVES

1. Obtain basic biological and life history information on bull trout in the North Fork Clearwater River below Dworshak Dam and the Clearwater River.

2. Determine migration patterns of bull trout present in the North Fork Clearwater River below Dworshak Dam

STUDY AREA

The CLW is a seventh order stream located in north-central Idaho. The CLW extends form its confluence with the Snake River, at Lewiston, Idaho, east to its confluence with the South Fork Clearwater River (SFC) at Kooskia, Idaho. Major tributaries to the CLW include the North Fork Clearwater River (NFC) (rkm 64.8) and the SFC (rkm 119.5). In this document, river kilometers are calculated from 0.0 rkm at the Snake and CLW river confluence. The NFC extends east 3.1 km to the base of Dworshak Dam. Dworshak Dam was constructed in 1971 without fish passage facilities, and is a permanent upstream migration barrier. Upstream of Dworshak Dam is Dworshak Reservoir and the remainder of the NFC. Dworshak and the NFC is a seventh order stream with a total drainage area of 739,982 ha. The MFC extends from Kooskia, Idaho (rkm 119.5), and east to the confluence of the Lochsa and Selway rivers (rkm 156.2) at Lowell, Idaho (Figure 20).

METHODS

Tagging

Bull trout were captured by hook-and-line and boat electrofishing techniques in the NFBD. Sampling was conducted between rkm 0.0 and rkm 3.1. All fish were handled and tagged as described in Part I of this report.

Tracking and Distribution

The Department and University of Idaho coordinated tracking efforts in 2003. Automobiles and fixed-wing aircraft were utilized on a monthly basis to monitor fish in the Lochsa, MFC, NFBD, and CLW rivers. In addition to mobile tracking we utilized three established stationary radio-receiving sites, maintained and operated by the University of Idaho. The Lochsa fixed site was

located at rkm 156.2, at Lowell, Idaho. The South Fork fixed site was located at rkm 6.2 on the SFC at Stites, Idaho. The Lewiston fixed site was located at rkm 6.7, approximately 3.0 km upstream of Lewiston, Idaho (Figure 20).

RESULTS

Tagging

Nine bull trout were collected on June 29 and 30, 2003 (Figure 21). One bull trout was a recapture, which had been radio-tagged in the Lochsa River 13 days earlier. Total length of all bull trout captured within the NFBD, excluding the recapture, ranged from 310 mm to 508 mm (mean 443.8 mm) and weight ranged from 300 g to 1,600 g (mean 1,072.5 g) (Figures 22 and 23). Radio transmitters were implanted in all eight bull trout. No length or weight information was collected on the recapture, because of the short duration between capture events.

Migration

All bull trout radio-tagged in the NFBD were detected after being released. Five remained in the vicinity, only migrating upstream/downstream a mean of 4.0 km from their release sites (range = 2.3 – 4.9 km) (Figures 24 and 25). Due to the unique circumstances concerning the remaining three fish, their migration distances were calculated separately. Fish 148.48.008 was detected near the confluence of the NFC and CLW (rkm 64.8) on July 7,2003 and August 8, 2003. This fish was illegally harvested and the angler turned in the transmitter. The exact date the fish was captured is unknown and the detections after August occurred while the transmitter was at Dworshak National Fish Hatchery prior to being deactivated.

Fish 148.48.001 was not detected for more than 3 months after tagging. It was detected on October 1, 4, 8 and 11, 2003 and November 22, 2003 on the Lochsa fixed site (rkm 156.1) (Figure 26). This fish was later detected on December 12, 2003 near Orofino (rkm 71.3) (Figure 26). Fish 148.48.001 had a total detected migration distance of 182.8 km in 2003.

Fish 148.48.002 was also not detected for more than three months after tagging, before being detected on October 4, 2003 at the Lochsa fixed site (rkm 156.1)(Figure 27). Fish 148.48.002 had a total detected migration distance of 91.4 km (Table 7). Fish 148.48.002 had no further detections in 2003.

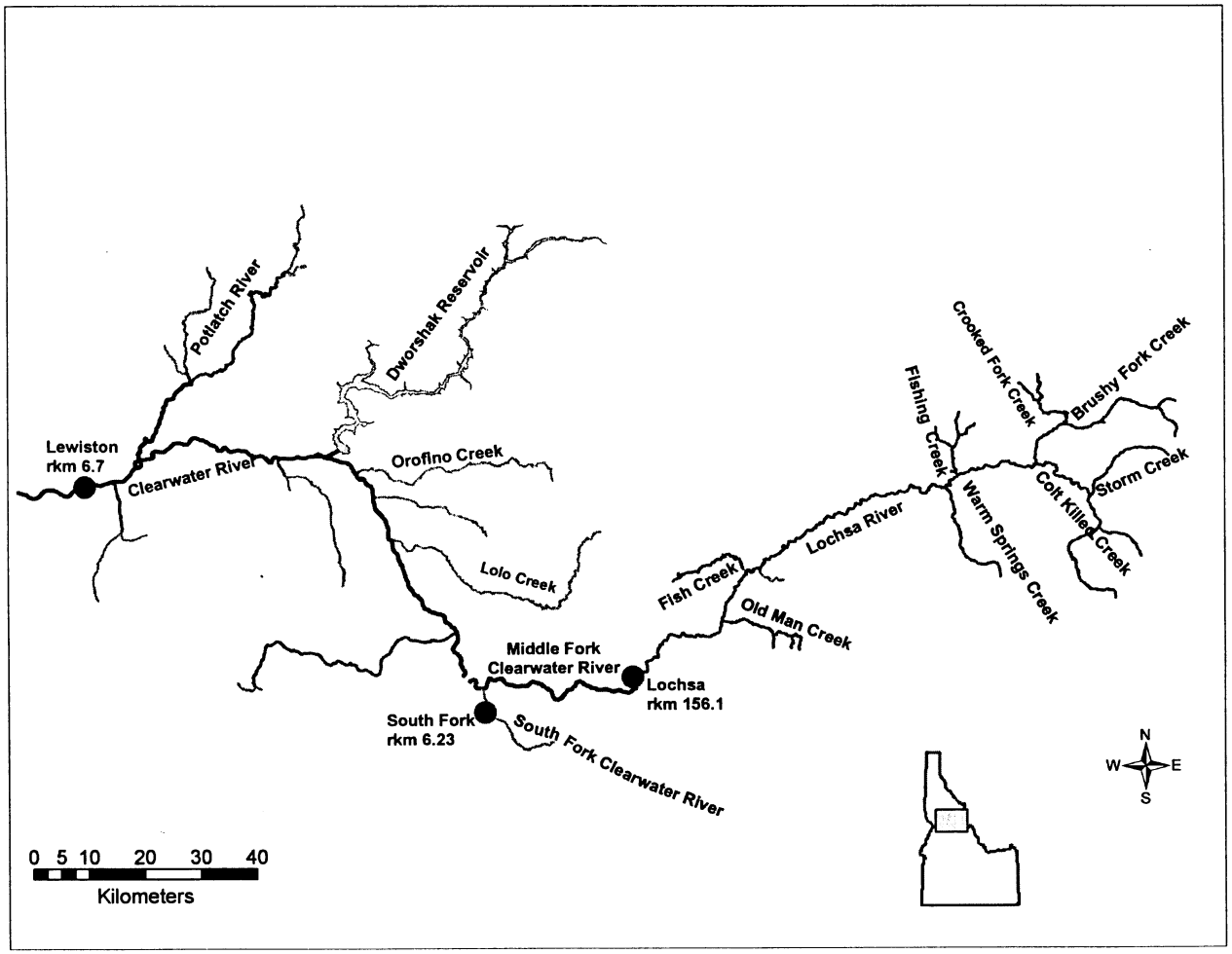

Figure 20. Overview map of the Clearwater, South Fork Clearwater, and Lochsa River drainages including major tributaries. Fixed telemetry site locations are indicated by a solid circle, they are located at the following rkm: Lewiston 6.7 (CWR), Stites 6.23 (SFC) and Lochsa 156.1 (MFC).

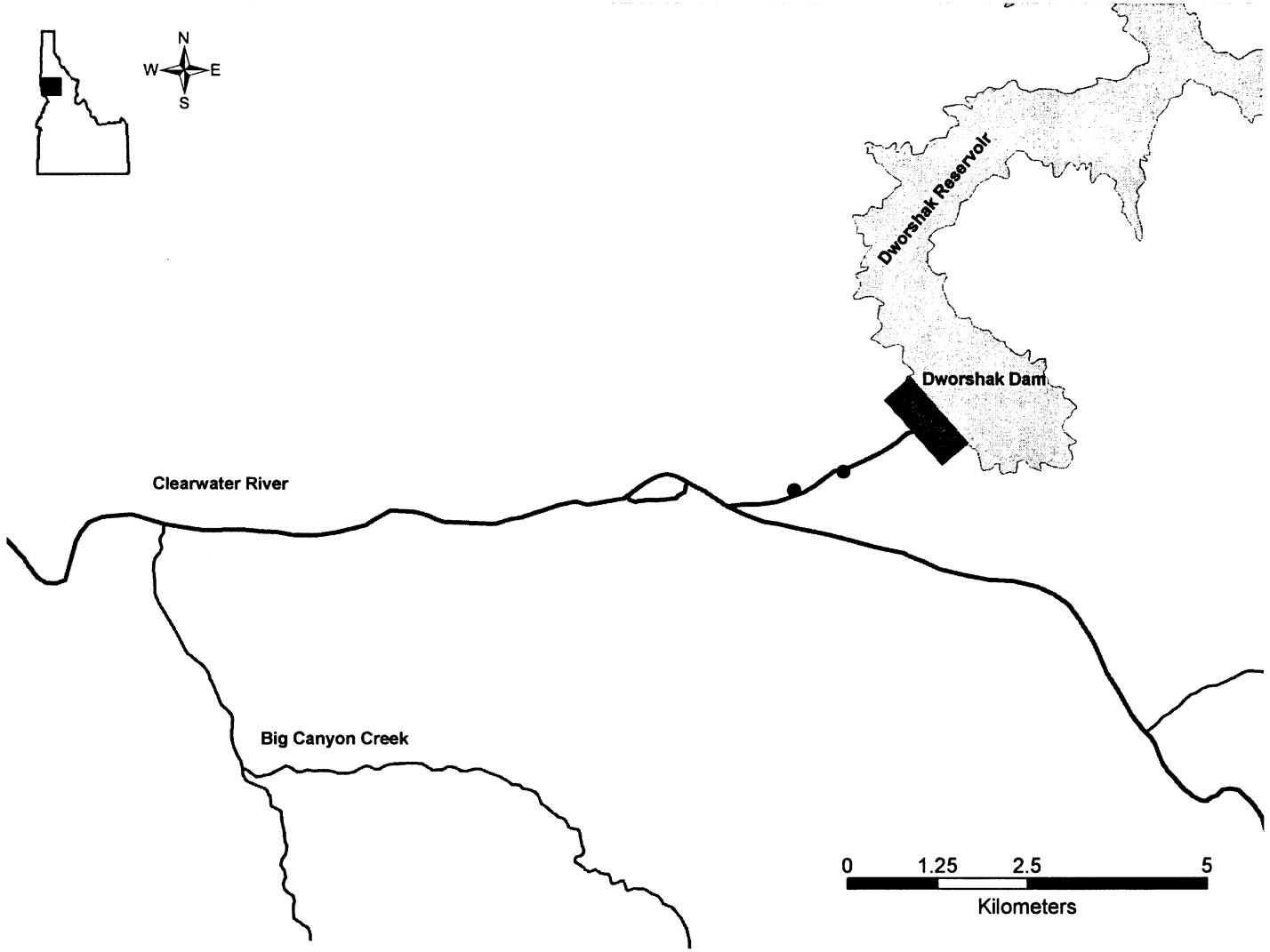

Figure 21. Bull trout capture locations in the North Fork Clearwater River, below Dworshak Dam, 2003.

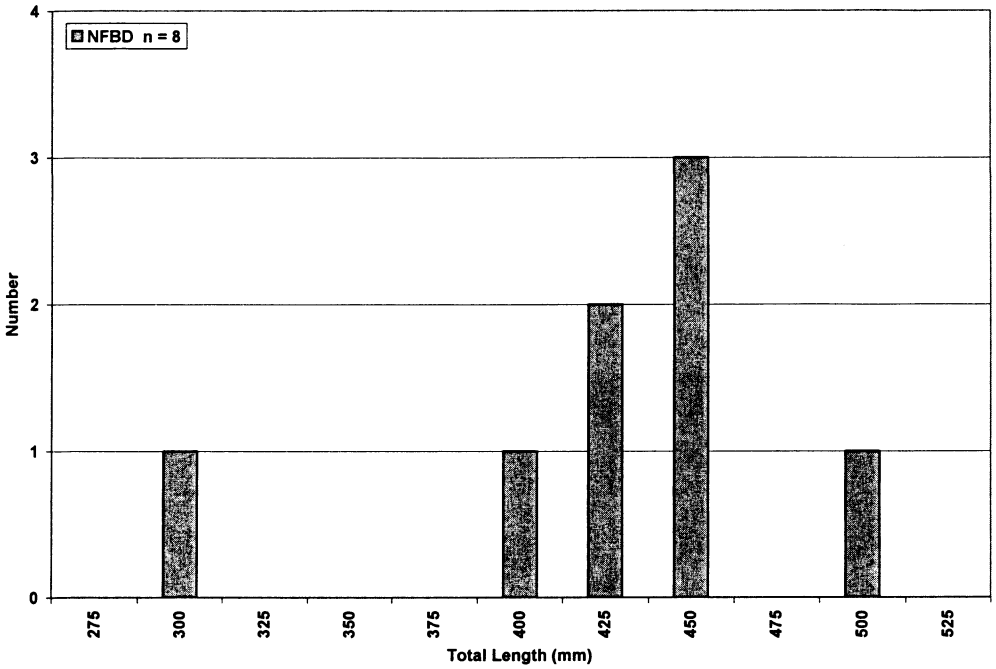

Figure 22. The total length of all bull trout captured in the North Fork Clearwater River below Dworshak Dam, 2003

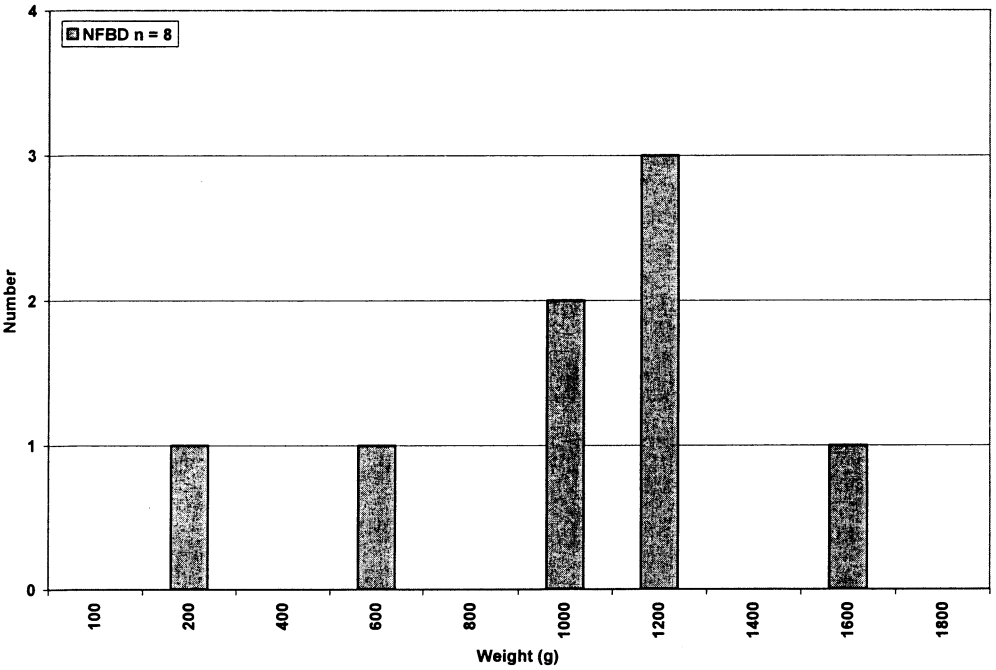

Figure 23. Weight range for all bull trout captured in the North Fork Clearwater below Dworshak Dam, 2003.

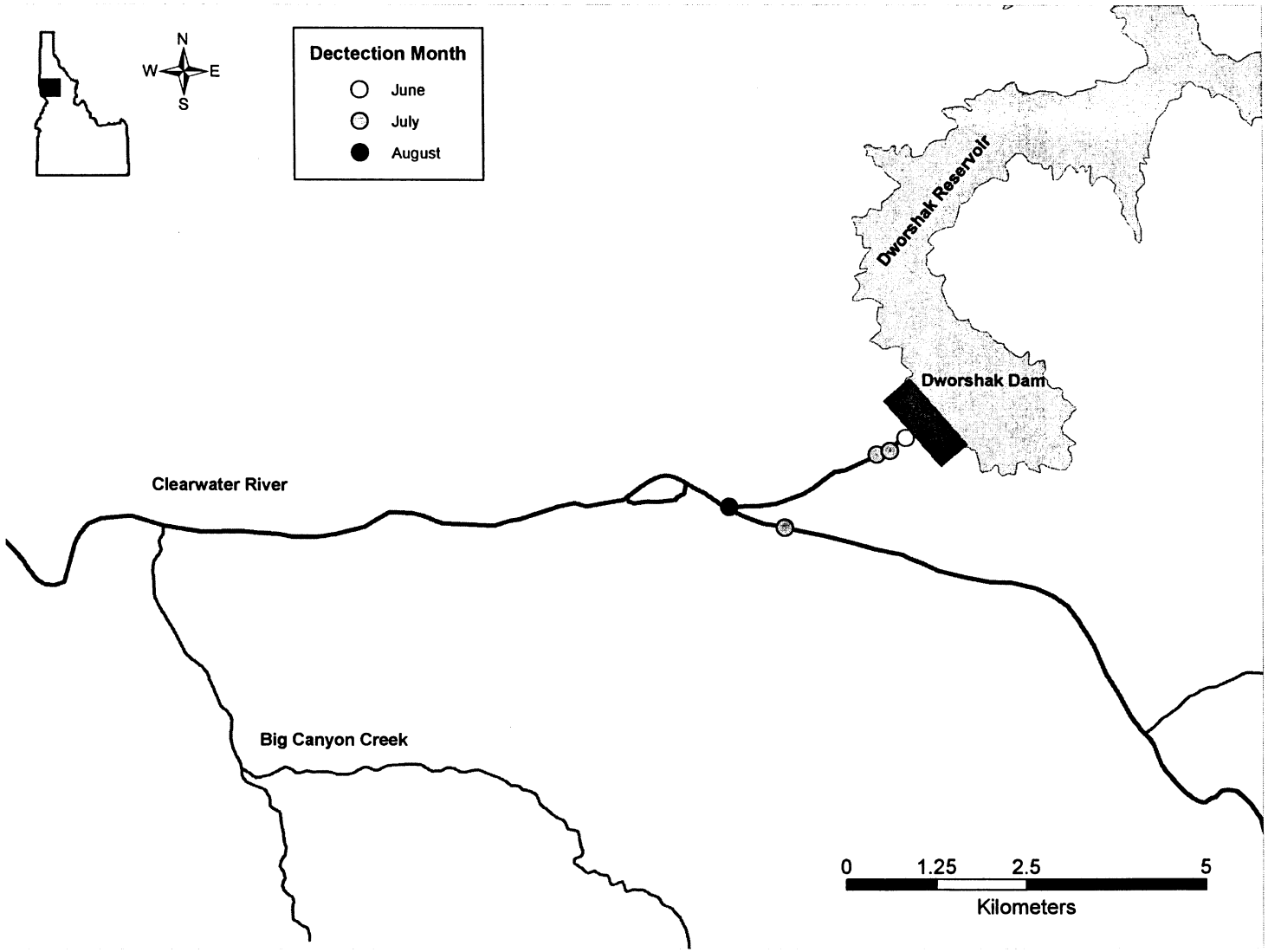

Figure 24. Distribution of radio-tagged bull trout below Dworshak Dam in the North Fork Clearwater and Clearwater rivers, June – August 2003.

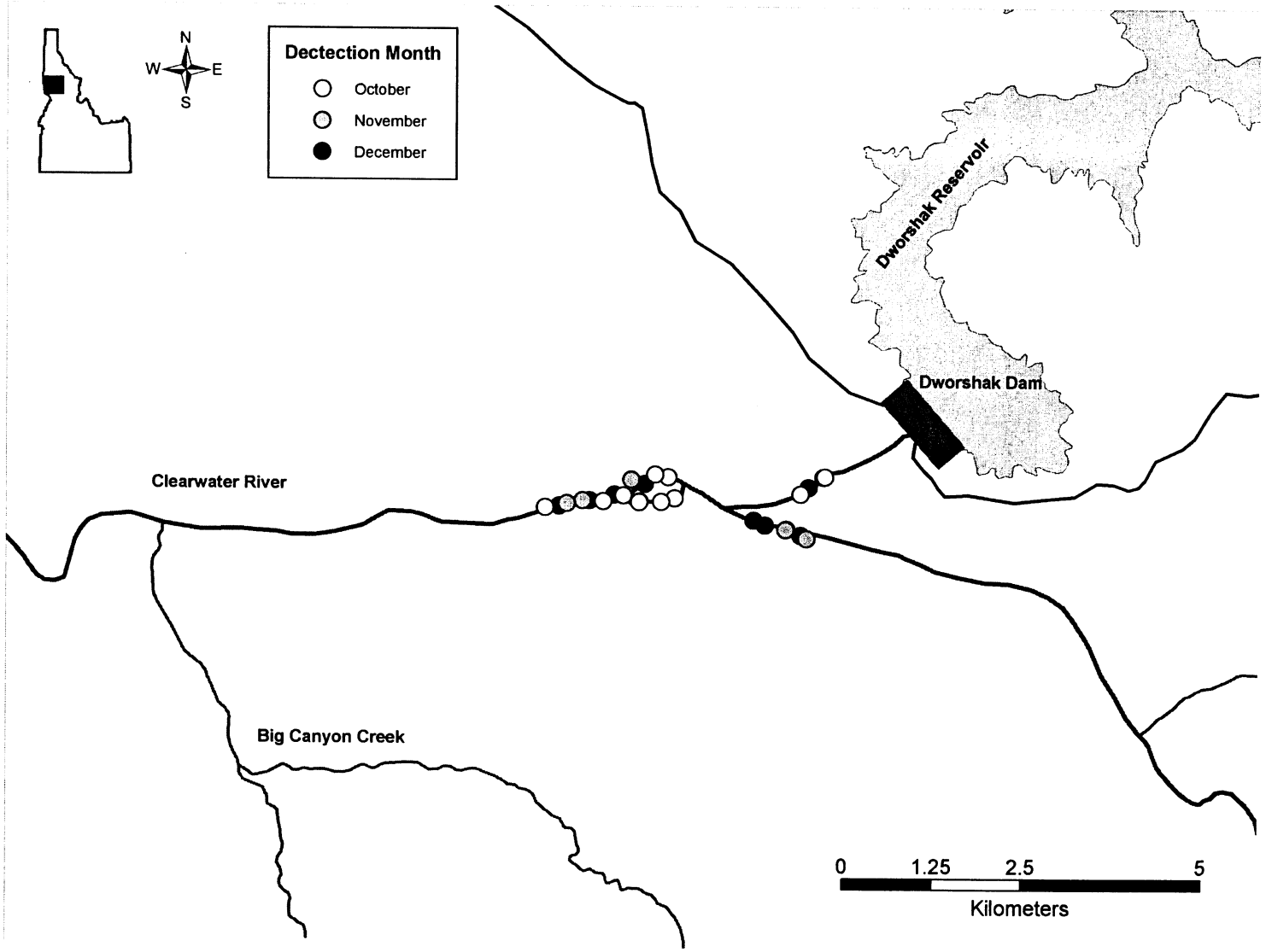

Figure 25. Distribution of radio-tagged bull trout below Dworshak Dam in the North Fork Clearwater and Clearwater rivers, October - December 2003.

Life History Information

Sex Ratio and Maturity

Maturity and sex determination was obtained on five of the eight fish collected in the NFBD. There was one male and four females. The sex ratio obtained was 0.25 males per female. There was one immature female; the remainder of the fish were found to be mature.

Length-weight relationship

Bull tout captured in the NFBD have a length weight relationship of log weight (g) = 3.2094 log total length (mm) - 5.4915 (mm) (Figure 28). Cochnauer et al. (2001) obtained a value of log weight (g) = 3.5551 log total length (mm) – 5.327 (mm). These values are not significantly different at the 95% confidence level.

DISCUSSION

Six of the eight bull trout tagged in the NFBD remained in the area around the NFC/CLW confluence. Three of these fish were mature individuals and were detected in an area with no known spawning habitat. The remaining two fish, 148.48.001 and 148.48.002, were not detected between their tagging dates June 29 and 30, 2003 and October1 and 4, 2003. The location of these fish during this three-month period is not known. Possible reasons for not detecting these fish include the interruption of fall tracking due to wildfires creating gaps in our tracking. On some weeks, aerial tracking between Orofino rkm 71.3 to Kooskia rkm 119.5 was not completed and car tracking was not efficient at detecting transmitters. Another possibility is that the fish migrated out of the study area. Our tracking was limited to the CLW, NFC, MFC, and Lochsa (including major tributaries). If the two bull trout moved into the Selway River, or any minor tributary of the MFC or Lochsa rivers, they would have been outside our detection area. Regardless of the lack of upstream migration data 148.48.001 and 148.48.002 were detected moving past the Lochsa fixed site during the time period consistent with the downstream migration timing of other fish that were tagged in the Lochsa (Schiff et al *in press*). Fish 148.48.001 was a mature female and 148.48.002 was a mature male, therefore they should have been seeking spawning areas.

Confounding this study is the migration pattern documented during a Department study being conducted in the Lochsa River drainage (Schiff et al. *in press*). In this study, fish 149.58.206 had a migration that was unique for bull trout tagged in the Lochsa. Sixteen of the 20 bull trout in the Lochsa moved into known spawning tributaries. However, 149.58.206 moved downstream into the lower CLW (rkm 6.7) an estimated 366.0 rkm downstream. It was also detected below Dworshak Dam in the NFBD (rkm 64.8). There are no known spawning areas in either location. One possible reason for this fish having an unusual migration could be that it was previously entrained through Dworshak Dam, and was attempting to return to its natal stream. Other studies (Schiff and Schriever 2003) confirmed that bull trout are entrained through Dworshak Dam. Another possibility is that this fish was an alternate year spawner that was returning to the lower reaches of the CLW for forage. Maturity and sex determination on this individual was inconclusive.

Additional research will be needed in the lower CLW and NFBD to determine the origin of these fish. We will need to identify if these fish originated from the NFC, Lochsa, Selway, South Fork Clearwater River or some other drainage. Also the relationship of coldwater releases from Dworshak Dam to fish distribution and utilization in the lower CLW and NFBD will need further study.

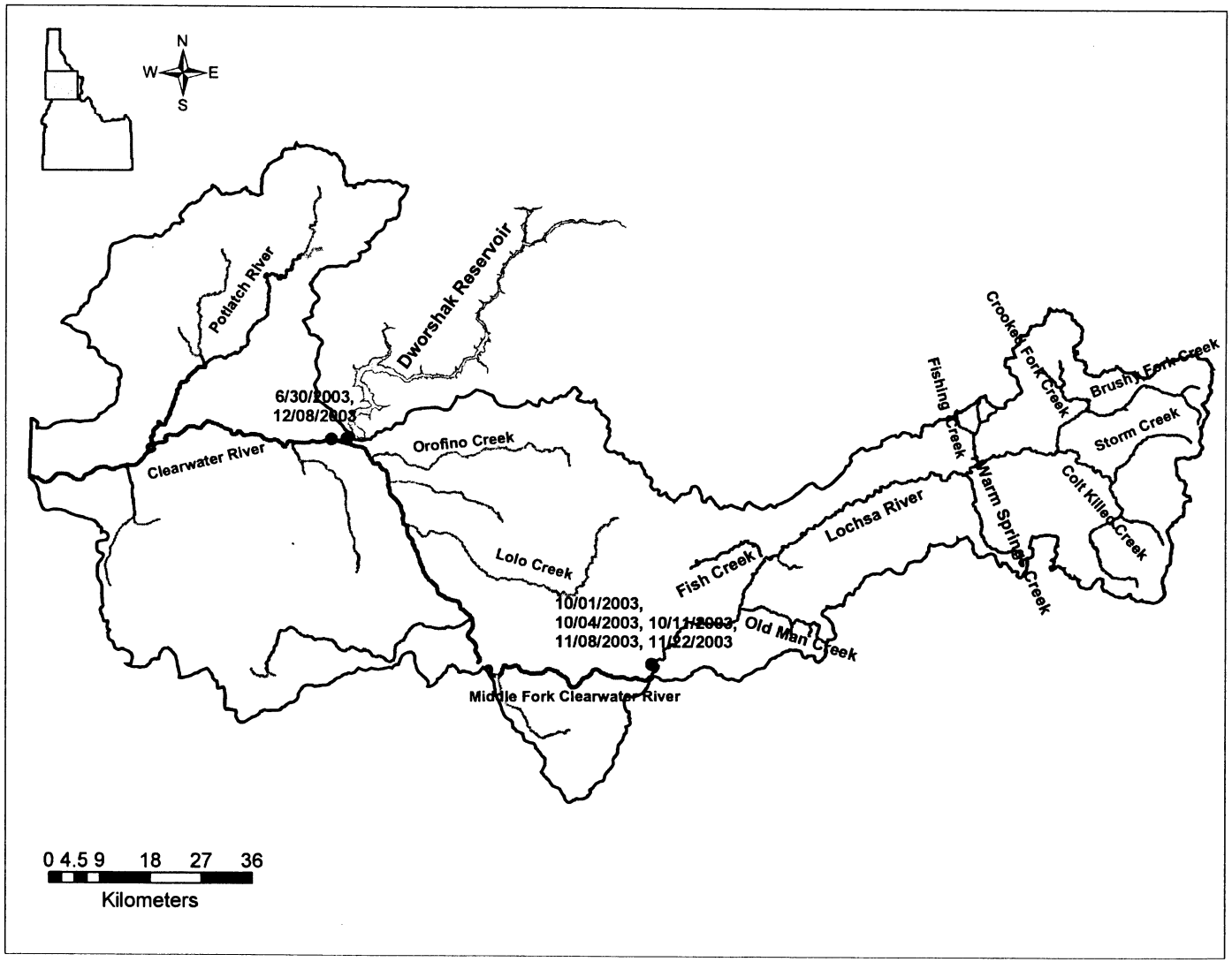

Figure 26. Migration distribution and relevant dates for fish 148.48.001 in the Clearwater, Lochsa, and Middle Fork Clearwater rivers, 2003.

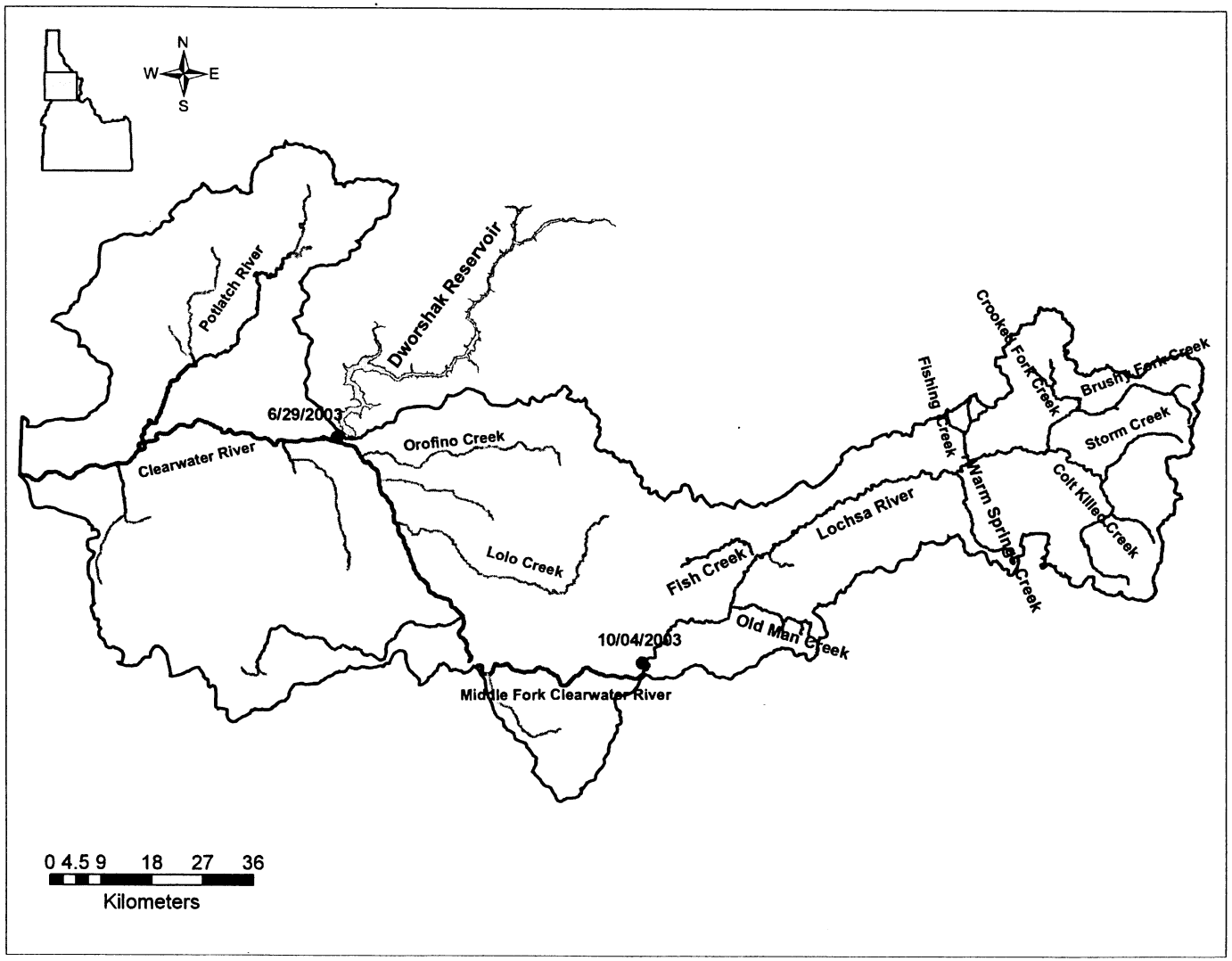

Figure 27. Migration distribution and relevant dates for fish 148.48.002 in the Clearwater, Lochsa, and Middle Fork Clearwater rivers, 2003.

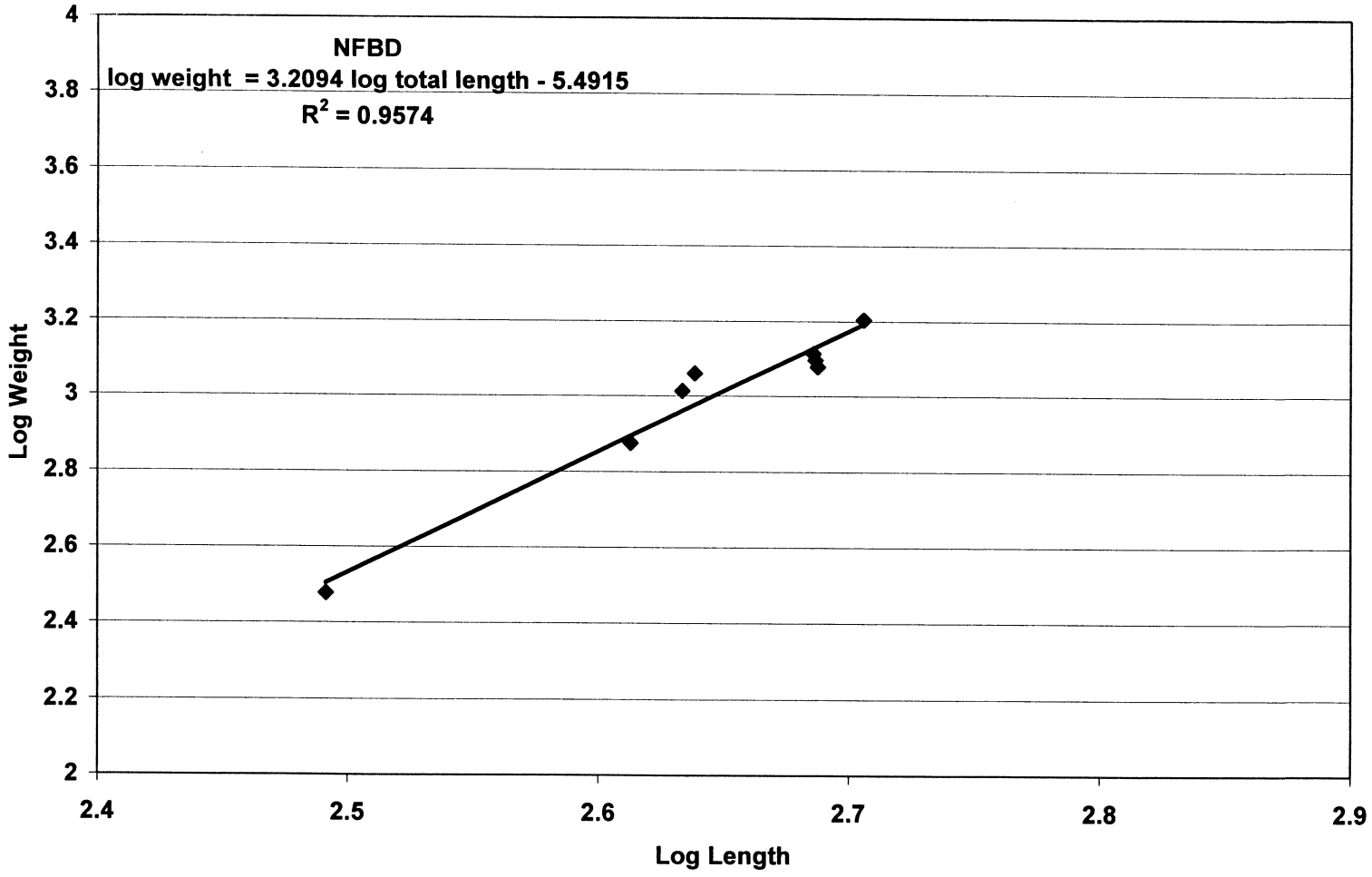

Figure 28. Log length – weight relationship for bull trout captured in the North Fork Clearwater River below Dworshak Dam, 2003.

ACKNOWLEDGEMENTS

We would like to thank the Army Corps of Engineers, Walla Walla District, the Bureau of Land Management, Cottonwood District, the US Forest Service, Clearwater National Forest and Idaho Department of Fish and Game for provided funding for this project. We would also like to thank Travis House, Malcolm Clemenhagen, Adam Moticak, Mike Shively, Robert Echert and Carolyn Whitney for field assistance.

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APPENDICES

Appendix A. All bull trout captured in the North Fork Clearwater River drainage in 2003.

PIT TAG Number	Frequency Code	Capture Date	Total Length (mm)	Fork Length (mm)	Weight (g)	Recapture	Group
3D9.1BF14B8680	148.48.002	4/13/2003	361		275	No	DWR
3D9.1BF146063F	148.74.001	4/13/2003	386		440	No	DWR
3D9.1BF1461263	148.74.006	4/13/2003	375		440	No	DWR
3D9.1BF1462817	148.76.001	4/13/2003	420		570	No	DWR
3D9.1BF1462857	148.76.002	4/13/2003	431		565	No	DWR
3D9.1BF14625F9		4/13/2003	315		190	No	DWR
3D9.1BF144695E	148.76.006	4/14/2003	503		1,260	No	DWR
3D9.1BF14465B0	148.48.003	4/16/2003	347		255	Yes	DWR
3D9.1BF145FC18		4/23/2003	304		175	No	DWR
3D9.1BF146020E	148.48.004	4/24/2003	475		1,018	Yes	DWR
3D9.1BF14B833D	148.76.004	4/24/2003	547		1,610	No	DWR
3D9.1BF146288C	148.74.002	4/25/2003	371		400	No	NFC
3D9.1BF1447320	148.48.004	4/25/2003	354		350	No	NFC
3D9.1BF14628F3	148.74.005	4/25/2003	370		410	No	NFC
3D9.1BF14B86F8	148.76.003	4/25/2003	427		680	No	NFC
3D9.1BF1444C38	148.76.007	4/25/2003	420		710	No	NFC
3D9.1BF14608FE	148.76.009	4/25/2003	425		690	No	NFC
3D9.1BF1460FF3	148.48.028	4/26/2003	330		249	No	DWR
3D9.1BF1444FED	148.48.026	4/27/2003	318		220	No	DWR
3D9.1BF145D330	148.74.009	4/27/2003	395		440	No	DWR
3D9.1BF146083D	148.48.008	4/28/2003	342		302	No	DWR
3D9.1BF145FA07	148.76.010	4/28/2003	538		1,700	No	DWR
3D9.1BF14601E9	148.48.021	4/29/2003	348		330	No	BFC
3D9.1BF14B86AD	148.48.022	4/29/2003	368		380	No	LNF
3D9.1BF1446E8C	148.74.004	4/29/2003	385		460	Yes	LNF
3D9.1BF14470A0	148.74.008	4/29/2003	405		500	No	NFC
3D9.1BF14625DD	148.74.010	4/29/2003	390		440	No	NFC
3D9.1BF14B83B2	148.76.011	4/29/2003	454		800	No	NFC
3D9.1BF1462674	148.76.011	4/29/2003	532		1,350	No	NFC
3D9.1BF14B8848	148.76.017	4/29/2003	533		1,510	No	NFC
3D9.1BF146064A	148.76.022	4/29/2003	442		720	No	NFC
3D9.1BF14B856F	148.76.023	4/29/2003	547		1,600	No	NFC
3D9.1BF145CFAA		4/29/2003	277		150	No	BFC
3D9.1BF146090B	148.74.016	5/02/2003	382		450	No	LNF
3D9.1BF145FA01	148.76.014	5/02/2003	437		720	No	LNF
3D9.1BF1446A6D	148.76.015	5/02/2003	418		690	No	LNF
3D9.1BF146150E		5/02/2003	450		810	No	LNF
3D9.1BF14B6C9E	148.48.001	5/03/2003	365		350	No	LNF
3D9.1BF146124F	148.48.025	5/03/2003	346		280	Yes	LNF
3D9.1BF1453679	148.76.012	5/03/2003	499		1,120	No	LNF
3D9.1BF14454F9	148.76.013	5/03/2003	501		1,080	No	LNF
3D9.1BF1446A72	148.76.016	5/03/2003	535		1,820	No	LNF

Appendix A. Continued.

PIT TAG Number	Frequency Code	Capture Date	Total Length (mm)	Fork Length (mm)	Weight (g)	Recapture	Group
3D9.1BF1416019	148.76.018	5/03/2003	445		750	No	LNF
3D9.1BF1446AF5	148.76.019	5/03/2003	574		1,960	No	LNF
3D9.1BF144A9E0	148.76.020	5/03/2003	471		1,020	No	LNF
3D9.1BF1444D57	148.76.021	5/03/2003	402		690	No	LNF
3D9.1BF14B808D	148.76.024	5/03/2003	452		880	No	LNF
3D9.1BF141F2BE	148.76.025	5/03/2003	480		840	No	LNF
3D9.1BF1448A32	148.48.024	5/04/2003	320		250	No	NFC
3D9.1BF1448F30	148.48.027	5/04/2003	358		360	No	NFC
3D9.1BF14A9836	148.74.003	5/04/2003	474		1,100	No	NFC
3D9.1BF144A1A6	148.74.007	5/04/2003	440		710	No	NFC
3D9.1BF1449FC4	148.74.014	5/04/2003	405		570	No	NFC
3D9.1BF1453676	148.74.015	5/04/2003	520		1,240	No	NFC
3D9.1BF1449C19	148.74.017	5/04/2003	403		570	No	NFC
3D9.1BF14A9FF7	148.74.018	5/04/2003	448		800	Yes	NFC
3D9.1BF1449CC9	148.74.020	5/04/2003	446		730	No	NFC
3D9.1BF1456CF7		5/04/2003	324		290	Yes	NFC
3D9.1BF14ABE3E	148.74.012	5/05/2003	375		430	No	DWR
3D9.1BF14AACED	148.76.037	5/05/2003	429		640	No	DWR
3D9.1BF145786F	148.48.032	5/06/2003	313		220	No	LNF
3D9.1BF1448974	148.76.027	5/06/2003	434		700	No	LNF
3D9.1BF14A9781	148.76.028	5/06/2003	561		1,700	No	LNF
3D9.1BF1449672	148.76.036	5/06/2003	492		1,120	No	LNF
3D9.1BF14A92FC	148.48.011	5/08/2003	335		260	No	LNF
3D9.1BF145741F	148.76.042	5/08/2003	457		790	No	LNF
3D9.1BF1449416	148.76.049	5/08/2003	545		1,610	No	LNF
3D9.1BF14AA283	148.76.050	5/08/2003	499		1,150	No	LNF
3D9.1BF1455D16		5/08/2003	419		540	No	LNF
	148.74.008	5/09/2003	403		462	Yes	NFC
3D9.1BF14496B3	148.74.022	5/09/2003	382		400	No	NFC
3D9.1BF14AB6CB	148.74.023	5/09/2003	382		465	No	NFC
3D9.1BF145373F	148.76.034	5/09/2003	474		930	No	NFC
3D9.1BF144928B	148.76.041	5/09/2003	463		810	No	NFC
3D9.1BF14AA2B4	148.76.047	5/09/2003	508		1,410	No	NFC
3D9.1BF1456BB8	148.76.048	5/09/2003	479		730	Yes	NFC
3D9.1BF1453699	148.76.045	5/09/2003	509		1,350	No	NFC
3D9.1BF141C2DE		5/09/2003	470		820	Yes	NFC
3D9.1BF1455F74	148.76.032	5/10/2003	502		1,125	No	LNF
3D9.1BF1449A7E	148.76.033	5/10/2003	650		2,600	No	LNF
3D9.1BF1422C7E	148.76.038	5/10/2003	458		700	Yes	LNF
3D9.1BF1446BD0		5/10/2003	541		1,330	Yes	LNF
.416C74103C		5/10/2003	654		2,000	Yes	LNF
3D9.1BF144A162	148.74.019	5/12/2003	356		400	No	NFC

Appendix A. Continued.

PIT TAG Number	Frequency Code	Capture Date	Total Length (mm)	Fork Length (mm)	Weight (g)	Recapture	Group
3D9.1BF145672F	148.74.021	5/12/2003	397		530	No	NFC
3D9.1BF1455CB1	148.74.024	5/12/2003	402		520	No	NFC
3D9.1BF1456244	148.76.039	5/12/2003	546		1,620	No	NFC
3D9.1BF144AE03	148.76.040	5/12/2003	480		925	No	NFC
3D9.1BF14560B0	148.76.043	5/12/2003	503		1,130	No	NFC
3D9.IBF14480F2	148.48.049	5/13/2003	300		205	No	NFC
3D9.1BF14AA76F	148.74.036	5/13/2003	386		450	No	NFC
3D9.1BF1455FB7	148.74.037	5/13/2003	424		610	No	NFC
3D9.1BF14AA8F6	148.76.026	5/13/2003	502		1,140	No	NFC
3D9.1BF16AFC73	148.76.029	5/13/2003	437		750	Yes	NFC
3D9.1BF1455FE3	148.76.030	5/13/2003	424		670	No	NFC
3D9.1BF14AB818	148.76.031	5/13/2003	434		640	No	NFC
3D9.1BF1449C30	148.76.035	5/13/2003	532		1,350	No	NFC
3D9.1BF1448DD4	148.76.044	5/13/2003	466		900	No	NFC
3D9.1BF1454277	148.76.046	5/13/2003	537		1,460	No	NFC
3D9.1BF1448A32		5/13/2003				Yes	NFC
3D9.1BF14ABDBF	148.48.020	5/15/2003	315		205	No	NFC
3D9.1BF1446A6D	148.76.015	5/15/2003	400		800	Yes	LNF
3D9.1BF14B8083	148.76.024	5/15/2003	452		1,000	Yes	LNF
3D9.1BF1448354	148.74.049	5/16/2003	408		600	No	LNF
3D9.1BF14A9815	148.48.023	5/17/2003	351		220	No	LNF
3D9.1BF1455FC7	148.74.033	5/17/2003	390		400	No	LNF
3D9.1BF1452A61	148.74.047	5/18/2003	465		900	No	NFC
3D9.1BF1449D57	148.74.048	5/18/2003	471		1,000	No	NFC
3D9.1BF14AA2AB	148.74.050	5/18/2003	478		1,100	No	DWR
3D9.1BF1456D15		5/18/2003	293		160	No	DWR
3D9.1BF14ABF45	148.74.038	5/19/2003	363		400	No	DWR
3D9.1BF1448FB7	148.74.045	5/19/2003	375		400	No	DWR
3D9.1BF1453D94	148.74.046	5/19/2003	468		900	No	NFC
3D9.1BF14AABD2	148.74.043	5/20/2003	440		800	No	LNF
3D9.1BF1456913		5/20/2003	345		300	No	LNF
3D9.1BF1455E53	148.74.042	5/22/2003	549		1,630	No	NFC
3D9.1BF14571DF	148.74.044	5/22/2003	395		540	No	NFC
3D9.1BF1457595		5/22/2003	515		1,360	Yes	NFC
3D9.1BF14AA9CT	148.48.015	5/23/2003	373		350	No	NFC
3D9.1BF1452E65	148.74.034	5/23/2003	547		1,830	No	NFC
3D9.1BF1455895	148.74.039	5/23/2003	500		1,200	No	NFC
3D9.1BF14AA924	148.74.040	5/23/2003	438		780	No	NFC
3D9.1BF14571DF	148.74.041	5/23/2003	400		500	No	NFC
3D9.1BF14562FF	148.48.012	5/24/2003	380		420	No	LNF
3D9.1BF14AADC5	148.48.016	5/24/2003	299		200	No	LNF
3D9.1BF1448BBA	148.74.026	5/24/2003	456		995	No	LNF

Appendix A. Continued.

PIT TAG Number	Frequency Code	Capture Date	Total Length (mm)	Fork Length (mm)	Weight (g)	Recapture	Group
3D9.1BF1449F37	148.74.032	5/24/2003	396		580	No	LNF
3D9.1BF14B83D2	148.74.035	5/24/2003	393		490	Yes	LNF
3D9.1BF1453B22	148.76.012	5/24/2003	501		1,110	Yes	LNF
3D9.1BF144853C		5/24/2003	523		1,220	Yes	LNF
3D9.1BF14AB19B	148.74.027	5/25/2003	542		1,695	No	LNF
3D9.1BF131A6F4	148.74.028	5/26/2003	691		3,400	No	LNF
3D9.1BF14A9EF5	148.74.025	5/30/2003	585		1,800	No	LNF
3D9.1BF14ABOD5	148.48.009	5/31/2003	312		220	No	LNF
3D9.1BF1452C84	148.48.010	5/31/2003	315		220	No	LNF
3D9.1BF1455B3O	148.48.014	5/31/2003	474		1,200	No	LNF
3D9.1BF141F1C6	148.48.019	5/31/2003	416		750	Yes	LNF
3D9.1BF144995A	148.48.013	6/01/2003	314		210	No	LNF
3D9.1BF144930E	148.48.050	6/01/2003	326		250	No	LNF
3D9.1BF14AB45C	148.74.029	6/01/2003	395		440	No	LNF
3D9.1BF14AB6E7	148.74.031	6/03/2003	411		600	No	LNF
3D9.1BF14AAA95	148.48.006	6/05/2003	298		230	No	LNF
3D9.1BF14AA802	148.48.007	6/05/2003	416		610	No	LNF
3D9.1BF14ABFA8	148.48.048	6/05/2003	343		365	No	LNF
3D9.1BF144B1CD	148.74.030	6/05/2003	551		1,820	No	LNF
3D9.1BF144853C		6/05/2003	523		1,220	Yes	LNF
3D9.1BF1448BA4	148.48.017	6/06/2003	414		630	No	NFC
3D9.1BF14491AF	148.48.018	6/06/2003	490		985	No	NFC
3D9.1BF14491AF	148.48.044	6/06/2003	400		600	No	NFC
3D9.1BF14A9B8F	148.48.045	6/06/2003	411		620	No	NFC
3D9.1BF144ACB2	148.48.046	6/06/2003	421		680	No	NFC
3D9.1BF14AA16B	148.48.047	6/06/2003	538		1,300	No	NFC
3D9.1BF14AA990		6/06/2003	514		1,320	No	NFC
3D9.1BF1456827	148.48.030	6/07/2003	448		630	No	NFC
3D9.1BF144A7C8	148.48.042	6/07/2003	437		780	No	NFC
3D9.1BF144885E	148.48.043	6/07/2003	438		630	No	NFC
XXX.4170690225		6/07/2003	507		985	Yes	NFC
3D9.1BF1456F2B	148.48.039	6/08/2003	334		300	No	LNF
3D9.1BF14AA9CB	148.48.040	6/08/2003	426		670	No	LNF
3D9.1BF14A9D09	148.48.041	6/08/2003	316		245	No	LNF
3D9.1BF14AC043	148.48.033	6/09/2003	480		1,065	No	NFC
3D9.1BF144AEF8	148.48.034	6/09/2003	456		1,000	No	NFC
3D9.1BF144A6FE	148.48.037	6/09/2003	392		735	No	NFC
3D9.1BF14A9AD5	148.48.038	6/09/2003	336		350	No	NFC
3D9.1BF1448994	148.48.029	6/10/2003	388		550	No	LNF
3D9.1BF144A557	148.48.031	6/10/2003	435		715	No	LNF
3D9.1BF1453BC5	148.48.035	6/10/2003	331		275	No	LNF
3D9.1BF144B15E	148.48.036	6/10/2003	437		790	No	LNF

Appendix A. Continued.

PIT TAG Number	Frequency Code	Capture Date	Total Length (mm)	Fork Length (mm)	Weight (g)	Recapture	Group
3D9.1BF1452D15	148.74.030	6/10/2003	460		1,000	No	LNF
3D9.1BF1452D15	148.74.030	6/13/2003	462		850	Yes	LNF
3D9.1BF1448E7D		6/13/2003	316		275	No	LNF
3D9.1BF144A547		6/13/2003	393		550	No	LNF
3D9.1BF144A7D5		6/14/2003	279		155	No	LNF
3D9.1BF144888D		6/14/2003	276		175	No	LNF
3D9.1BF144930E	148.48.050	6/15/2003	325		250	Yes	LNF
3D9.1BF1455FC7	148.74.033	6/15/2003	392		500	Yes	LNF
3D9.1BF144812A		6/15/2003	292		205	No	LNF
3D9.1BF14486CE		6/15/2003	286		220	No	LNF
3D9.1BF1455CA1		6/15/2003	351		350	No	LNF
3D9.1BF144B1F2		6/15/2003	351		400	No	LNF
3D9.1BF14AB713		6/15/2003	375		450	No	LNF
3D9.1BF145C3A6		6/15/2003	394		500	Yes	LNF
3D9.1BF1456D78		6/15/2003	406		500	No	LNF
3D9.1BF1456C29		6/15/2003	440		810	No	LNF
3D9.1BF1455DF4		6/15/2003	366		3,510	No	LNF
3D9.1BF141F1C6	148.48.019	6/16/2003	425		700	Yes	LNF
3D9.1BF14AB450		6/16/2003	343		310	No	LNF
3D9.1BF1448A12		6/16/2003	345		350	No	LNF
3D9.1BF14538A8		6/16/2003	357		350	No	LNF
3D9.1BF168A764		6/16/2003	379		450	Yes	LNF
3D9.1BF145C3A6		6/16/2003	394		500	Yes	LNF
3D9.1BF1448DDF	148.48.001	6/29/2003	508		1,600	No	CLW
3D9.1BF1455840	148.48.005	6/29/2003	487		1,200	No	CLW
3D9.1BF144886F	148.48.009	6/29/2003	430		1,030	No	CLW
3D9.1BF1449574	148.48.002	6/30/2003	485		1,300	No	CLW
3D9.1BF14AA87F	148.48.004	6/30/2003	435		1,150	No	CLW
3D9.1BF1456BFE	148.48.006	6/30/2003	410		750	No	CLW
3D9.1BF144A597	148.48.008	6/30/2003	486		1,250	No	CLW
3D9.1BF14AB6D0	148.48.010	6/30/2003	310		300	No	CLW
	149.58.206	6/30/2003				Yes	CLW
3D9.1BF1448610	376.80.001	10/02/2003	497		1,460	No	NFC
3D9.1BF1448B48	376.80.002	10/02/2003	509		1,220	No	NFC
3D9.1BF14A9F4C	376.80.003	10/02/2003	390		700	No	NFC
3D9.1BF14AB68E	376.80.004	10/02/2003	577		2,150	No	NFC
3D9.1BF14A9CE6	376.80.005	10/02/2003	511		1,220	No	LNF
3D9.1BF14AA151	376.80.008	10/02/2003	466		990	No	LNF
3D9.1BF145713D	376.80.027	10/02/2003	471		830	No	NFC
3D9.1BF144947E	376.80.028	10/02/2003	386		660	No	NFC
3D9.1BF1448A68	376.80.007	10/03/2003	619		2,510	No	LNF
3D9.1BF14491B0	376.80.026	10/03/2003	515		1,360	No	NFC

Appendix A. Continued.

PIT TAG Number	Frequency Code	Capture Date	Total Length (mm)	Fork Length (mm)	Weight (g)	Recapture	Group
3D9.1BF14AA213	376.80.029	10/03/2003	435		790	No	NFC
3D9.1BF1448C9B	376.80.030	10/03/2003	455		900	No	NFC
3D9.1BF144B00C		10/03/2003	326		305	No	LNF
3D9.1BF1448E8C	376.80.006	10/04/2003	569		1,880	No	BFC
3D9.1BF14B7435	376.80.034	10/04/2003	505		1,310	Yes	NFC
3D9.1BF14483AD	376.80.040	10/04/2003	513		1,200	No	NFC
3D9.1BF14496D3	376.80.044	10/04/2003	400		610	No	NFC
3D9.1BF1449CF0	376.80.045	10/04/2003	464		910	No	NFC
3D9.1BF14ABA96	376.80.046	10/04/2003	517		1,220	No	NFC
3D9.1BF144B0F8	376.80.052	10/04/2003	559		1,620	No	NFC
3D9.1BF144ACAF		10/04/2003	300		360	No	NFC
3D9.1BF14ABAC8	376.80.058	10/05/2003	452		860	No	NFC
3D9.1BF1449FE5	376.80.059	10/05/2003	403		630	No	NFC
3D9.1BF1453900	376.80.062	10/05/2003	472		910	No	NFC
3D9.1BF14ABD72	376.80.064	10/05/2003	414		700	No	NFC
3D9.1BF1448F2E	376.80.073	10/06/2003	467		790	No	NFC
3D9.1BF14487D2	376.80.080	10/06/2003	477		1,050	No	NFC
3D9.1BF14B2325	376.80.082	10/06/2003	507		1,360	No	NFC
3D9.1BF14AA0BD	376.80.086	10/06/2003	512		1,360	No	NFC
3D9.1BF1456728	376.80.087	10/06/2003	491		1,190	No	NFC
3D9.1BF14AB977	376.80.089	10/06/2003	365		560	No	NFC
3D9.1BF141D142		10/06/2003	480		950	Yes	NFC
3D9.1BF14AB963	376.80.072	10/07/2003	403		580	No	NFC
3D9.1BF14608FE		10/07/2003	431		710	Yes	NFC
3D9.1BF1448E88	376.80.010	10/17/2003	513		1,370	No	LNF
3D9.1BF144942F	376.80.092	10/17/2003	520		1,400	No	LNF
3D9.1BF1449DC6	376.80.100	10/17/2003	513		1,370	No	LNF
3D9.1BF145297C	376.80.101	10/17/2003	539		1,350	Yes	LNF
3D9.1BF1449FAD		10/17/2003	360		395	No	LNF
3D9.1BF1452AB8	376.80.011	10/18/2003	496		1,210	No	LNF
3D9.1BF1449B77	376.80.013	10/18/2003	603		2,280	No	LNF
3D9.1BF144819B		10/18/2003	288		195	No	LNF
3D9.1BF14564C5	376.80.009	10/19/2003	458		895	No	LNF
3D9.1BF144924F	376.80.012	10/19/2003	531		1,505	No	LNF
3D9.1BF1453B48	376.80.014	10/19/2003	408		695	No	LNF
3D9.1BF14485CA	376.80.015	10/19/2003	412		595	Yes	LNF
3D9.1BF14AABAA	376.80.018	10/19/2003	495		1,195	No	LNF
3D9.1BF144AF20	376.80.017	10/20/2003	391		650	No	LNF
3D9.1BF1457DDC	376.80.023	10/20/2003	478		1,020	No	LNF
3D9.1BF14A98A7	376.80.025	10/20/2003	413		725	No	LNF
3D9.1BF1449832		10/20/2003	360		430	No	LNF
3D9.1BF1449FAD		10/20/2003	362		450	Yes	LNF

Appendix A. Continued.

PIT TAG Number	Frequency Code	Capture Date	Total Length (mm)	Fork Length (mm)	Weight (g)	Recapture	Group
3D9.1BF1436A7E	376.80.016	10/21/2003	408		725	No	LNF
3D9.1BF14ADDBF	376.80.020	10/21/2003	478		990	No	NFC
3D9.1BF14AA827	376.80.021	10/21/2003	456		905	No	LNF
3D9.1BF14AB713	376.80.022	10/21/2003	408		815	Yes	LNF
3D9.1BF144A7CC		10/21/2003	430		825	Yes	LNF
3D9.1BF14481BD		10/21/2003	508		1,200	Yes	LNF
3D9.1BF14494A5		10/21/2003	555		1,495	Yes	LNF
3D9.1BF1453690	376.80.019	10/30/2003	505		1,130	No	NFC

Appendix B. Radio-tagged bull trout distribution in the North Fork Clearwater River, 2003.

Bull Trout Radio Number Frequency-Code	Tagging Subgroup	Watershed Group 2003	Date Past Fixed Site Upstream	Date located at Maximum Migration Point[a]	Date Past Fixed Site Downstream	Migration Distance From Tagging Location 2003 (km)[b]
148.74.008	NFC	Beaver Creek		8/18/2003		49.57
148.74.017	NFC	Beaver Creek (Isabella Creek)		7/2/03 (8/18/03)		9.83
148.48.038	NFC	Cold Springs Creek		9/01/2003		82.50
148.74.024	NFC	Cold Springs Creek		8/18/2003		86.27
148.48.006	LNF	Floodwood Creek		7/21/2003		
148.48.007	LNF	Floodwood Creek		7/07/2003		
148.48.010	LNF	Floodwood Creek		7/21/2003		3.85
148.48.035	LNF	Floodwood Creek		9/01/2003		6.00
148.48.039	LNF	Floodwood Creek		8/18/2003		6.29
148.76.031	NFC	Floodwood Creek	6/14/2003	9/28/2003		26.89
148.48.018	NFC	Headwaters NFC		7/21/2003		107.58
148.48.042	NFC	Headwaters NFC		9/01/2003		124.78
148.74.003	NFC	Headwaters NFC		8/07/2003		123.34
148.74.027	LNF	Headwaters NFC		8/18/2003		128.93
148.74.034	NFC	Headwaters NFC		8/07/2003		127.48
148.74.039	NFC	Headwaters NFC		8/07/2003		127.38
148.74.046	NFC	Headwaters NFC		7/21/2003		
148.74.047	NFC	Headwaters NFC		7/21/2003		123.51
148.76.004	DWR	Headwaters NFC		8/07/2003		165.00
148.76.008	NFC	Headwaters NFC		8/18/2003		
148.76.011	NFC	Headwaters NFC		8/07/2003		169.15
148.76.017	NFC	Headwaters NFC	6/12/2003	8/07/2003		160.61

Appendix B. Continued.

Bull Trout Radio Number Frequency-Code	Tagging Subgroup	Watershed Group 2003	Date Past Fixed Site Upstream	Date located at Maximum Migration Point[a]	Date Past Fixed Site Downstream	Migration Distance From Tagging Location 2003 (km)[b]
148.76.023	NFC	Headwaters NFC		7/21/2003		159.15
148.76.034	NFC	Headwaters NFC		8/07/2003		127.98
148.76.035	NFC	Headwaters NFC	6/14/2003	8/07/2003		122.79
148.76.037	DWR	Headwaters NFC	6/13/2003	8/07/2003		162.98
148.76.044	NFC	Headwaters NFC		7/07/2003		116.29
148.76.045	NFC	Headwaters NFC			8/07/2003	
148.76.046	NFC	Headwaters NFC	6/11/2003			128.19
148.76.047	NFC	Headwaters NFC		7/21/2003		124.93
148.74.005	NFC	Isabella Creek		7/21/2003		9.00
148.74.015	NFC	Isabella Creek		7/21/2003	10/01/2003	14.31
148.74.018	NFC	Isabella Creek		7/07/2003	10/19/2003	9.15
148.74.036	NFC	Isabella Creek		7/07/2003	10/14/2003	9.65
148.74.041	NFC	Isabella Creek		7/07/2003		9.81
148.76.003	NFC	Isabella Creek		8/18/2003	10/06/2003	9.14
148.76.026	NFC	Isabella Creek		7/07/2003	10/09/2003	13.29
148.76.041	NFC	Isabella Creek	6/16/2003	6/29/2003	8/01/2003	7.05
148.74.014	NFC	Kelly Creek		7/07/2003		94.99
148.74.044	NFC	Kelly Creek		8/18/2003		104.02
148.48.017	NFC	Long Creek		8/18/2003		110.10
148.48.019	LNF	Long Creek		7/21/2003		
148.48.029	LNF	Long Creek		8/18/2003		167.42
148.48.032	LNF	Long Creek		7/21/2003		
148.48.045	NFC	Long Creek		9/01/2003		111.16
148.74.022	NFC	Long Creek		8/07/2003		113.60
148.74.048	NFC	Long Creek		8/07/2003		118.62
148.76.009	NFC	Long Creek		8/07/2003		98.07
148.76.010	DWR	Long Creek		8/07/2003		160.99
148.76.022	NFC	Long Creek	6/13/2002	7/21/2003		153.04
148.76.029	NFC	Long Creek		8/07/2003		109.76
148.74.006	DWR	Lost Pete Creek		7/07/2003		60.11
148.74.010	NFC	Lost Pete Creek		7/07/2003		53.81
148.48.048	LNF	Lower LNF				4.71
148.48.002	DWR	Middle Dworshak Reservoir				77.77

Appendix B. Continued

Bull Trout Radio Number Frequency-Code	Tagging Subgroup	Watershed Group 2003	Date Past Fixed Site Upstream	Date located at Maximum Migration Point[a]	Date Past Fixed Site Downstream	Migration Distance From Tagging Location 2003 (km)[b]
148.48.003	DWR	Middle Dworshak Reservoir				
148.48.011	LNF	Middle LNF	6/26/2003	9/15/2003	10/11/2003	16.35
148.48.016	LNF	Middle LNF	6/26/2003	8/18/2003	10/27/2003	14.10
148.48.025	LNF	Middle LNF	7/02/2003	7/21/2003	10/28/2003	3.78
148.48.036	LNF	Middle LNF	6/28/2003	8/18/2003		27.22
148.48.041	LNF	Middle LNF	7/01/2003	8/07/2003		22.53
148.74.009	DWR	Middle LNF	70/6/2003	8/18/2003	10/13/2003	47.32
148.74.031	LNF	Middle LNF		9/15/2003	10/15/2003	19.89
148.74.032	LNF	Middle LNF		7/21/2003	10/16/2003	9.30
148.74.033	LNF	Middle LNF	6/17/2003	7/17/2003	10/15/2003	4.15
148.74.040	NFC	Middle LNF	6/26/2003	9/29/2003	10/10/2003	31.50
148.76.012	LNF	Middle LNF	6/11/2003	7/07/2003	10/13/2003	9.46
148.76.018	LNF	Middle LNF	6/13/2003	7/07/2003	10/13/2003	22.49
148.76.021	LNF	Middle LNF		7/21/2003		23.34
148.48.001	LNF	Mortality				
148.48.004	NFC	Mortality				
148.48.008	DWR	Mortality				
148.48.015	NFC	Mortality				
148.48.023	LNF	Mortality				
148.48.024	NFC	Mortality				
148.48.026	DWR	Mortality				
148.48.028	DWR	Mortality				
148.48.047	NFC	Mortality				10.12
148.74.007	NFC	Mortality				
148.76.001	DWR	Mortality				
148.76.002	DWR	Mortality				
148.74.029	LNF	NFC		9/29/2003	10/21/2003	22.90
148.74.023	NFC	Quartz Creek		7/21/2003		25.88
148.76.043	NFC	Quartz Creek	6/14/2003	7/07/2003	7/25/2003	
148.48.030	NFC	Schofield Creek		8/18/2003		50.64
148.74.019	NFC	Schofield Creek		6/29/2003		27.81
148.74.045	DWR	Schofield Creek		9/15/2003		75.43
148.48.049	NFC	Schofield Creek (Quartz Creek)		7/21/03 (8/18/03)		40.51
148.48.020	NFC	Skull Creek		7/21/2003		25.41
148.48.027	NFC	Skull Creek		9/19/2003		24.44
148.76.015	LNF	Skull Creek	6/27/2003	8/07/2003		59.00
148.76.016	LNF	Skull Creek	7/24/2003	8/18/2003		58.16

Appendix B. Continued.

Bull Trout Radio Number Frequency-Code	Tagging Subgroup	Watershed Group 2003	Date Past Fixed Site Upstream	Date located at Maximum Migration Point[a]	Date Past Fixed Site Downstream	Migration Distance From Tagging Location (km)[1] 2003
148.76.030	NFC	Skull Creek	6/12/2003	8/17/2003		32.42
148.76.048	NFC	Skull Creek		7/07/2003		24.52
148.76.040	NFC	Skull Creek (Upper LNF)		6/29/03 (8/18/03)	7/27/2003 (10/10/2003)	36.12
148.48.022	LNF	Stony Creek			7/07/2003	16.25
148.74.016	LNF	Stony Creek		7/07/2003		11.26
148.48.044	NFC	Upper Cayuse Creek		9/01/2003	10/17/2003	112.95
148.48.046	NFC	Upper Cayuse Creek		8/18/2003		121.71
148.74.038	DWR	Upper Dworshak				
148.48.033	NFC	Upper Kelly Creek		8/18/2003		99.03
148.48.034	NFC	Upper Kelly Creek		8/18/2003		122.50
148.48.043	NFC	Upper Kelly Creek		7/21/2003		112.74
148.74.020	NFC	Upper Kelly Creek		8/18/2003		179.60
148.74.021	NFC	Upper Kelly Creek		7/21/2003		108.37
148.76.007	NFC	Upper Kelly Creek		8/07/2003		125.48
148.76.039	NFC	Upper Kelly Creek		7/21/2003		123.36
148.48.009	LNF	Upper LNF	6/19/2003	8/18/2003		
148.48.012	LNF	Upper LNF	6/16/2003	7/21/2003	10/09/2003	22.61
148.48.014	LNF	Upper LNF	6/17/2003	8/07/2003	10/14/2003	14.25
148.48.021	BFC	Upper LNF		9/01/2003	10/18/2003	35.63
148.48.031	LNF	Upper LNF	6/17/2003	8/18/2003	10/14/2003	40.62
148.48.040	LNF	Upper LNF	6/18/2003	9/01/2003		29.53
148.48.050	LNF	Upper LNF	6/15/2003	7/21/2003	10/18/2003	31.60
148.74.001	DWR	Upper LNF	6/26/2003	7/21/2003	10/14/2003	68.30
148.74.004	LNF	Upper LNF	7/02/2003	8/07/2003		
148.74.011	LNF	Upper LNF		8/18/2003		
148.74.012	DWR	Upper LNF	6/26/2003	8/07/2003	10/14/2003	
148.74.013	LNF	Upper LNF		8/07/2003	10/10/2003	
148.74.025	LNF	Upper LNF	6/18/2003	9/15/2003	10/16/2003	
148.74.026	LNF	Upper LNF		7/07/2003		
148.74.028	LNF	Upper LNF		8/07/2003		
148.74.035	LNF	Upper LNF	6/17/2003	8/18/2003		

Appendix B. Continued.

Bull Trout Radio Number Frequency-Code	Tagging Subgroup	Watershed Group 2003	Date Past Fixed Site Upstream	Date located at Maximum Migration Point[a]	Date Past Fixed Site Downstream	Migration Distance From Tagging Location 2003 (km)[b]
148.74.042	NFC	Upper LNF	6/11/2003	8/18/2003	10/09/2003	
148.74.043	LNF	Upper LNF	6/10/2003	7/21/2003		
148.74.049	LNF	Upper LNF	6/10/2003	10/15/2003		
148.74.050	DWR	Upper LNF		7/21/2003	10/18/2003	
148.76.005	DWR	Upper LNF		8/18/2003	10/15/2003	
148.76.006	DWR	Upper LNF		7/21/2003	10/06/2003	
148.76.013	LNF	Upper LNF		7/21/2003		
148.76.019	LNF	Upper LNF		9/15/2003	10/11/2003	29.87
148.76.020	LNF	Upper LNF	6/12/2003	8/18/2003	10/30/2003	42.28
148.76.024	LNF	Upper LNF	6/11/2003	7/07/2003	10/20/2003	
148.76.025	LNF	Upper LNF	6/24/2003	7/21/2003	10/13/2003	49.71
148.76.027	LNF	Upper LNF	6/16/2003	8/07/2003	10/19/2003	30.18
148.76.028	LNF	Upper LNF		7/07/2003		
148.76.032	LNF	Upper LNF	6/12/2003	8/07/2003	10/16/2003	34.5
148.76.033	LNF	Upper LNF		8/07/2003	10/13/2003	37.97
148.76.036	LNF	Upper LNF		8/07/2003	10/12/2003	39.21
148.76.038	LNF	Upper LNF	6/14/2003	7/07/2003	10/14/2003	28.8
148.76.042	LNF	Upper LNF	6/13/2003	7/21/2003		49.29
148.76.049	LNF	Upper LNF		8/07/2003	10/12/2003	47.04
148.76.050	LNF	Upper LNF		7/07/2003	10/18/2003	
148.74.030	LNF	Upper NFC		7/21/2003		134.17
148.74.002	NFC	Upper Weitas Creek		9/01/2003		78.96
148.74.037	NFC	Upper Weitas Creek		8/07/2003		68.77
148.48.013	LNF			6/10/2003		
148.76.014	LNF		6/17/2003		10/14/2003	
376.80.001	NFC					138.64
376.80.002	NFC					45.72
376.80.003	NFC					129.24
376.80.004	NFC					141.50
376.80.005	LNF					51.06
376.80.006	BFC					56.07
376.80.007	LNF					43.10
376.80.008	LNF					69.08
376.80.009	LNF					43.28
376.80.010	LNF					44.35
376.80.011	LNF					33.36
376.80.012	LNF					63.49
376.80.013	LNF					50.75
376.80.014	LNF					66.65

Appendix B. Continued.

Bull Trout Radio Number Frequency-Code	Tagging Subgroup	Watershed Group 2003	Date Past Fixed Site Upstream	Date located at Maximum Migration Point[a]	Date Past Fixed Site Downstream	Migration Distance From Tagging Location 2003 (km)[b]
376.80.015	LNF					49.82
376.80.016	LNF					52.33
376.80.017	LNF					57.22
376.80.018	LNF					42.45
376.80.019	NFC					36.41
376.80.020	NFC					84.02
376.80.021	LNF					65.79
376.80.022	LNF					61.25
376.80.023	LNF					54.39
376.80.025	LNF					53.04
376.80.026	NFC					
376.80.027	NFC					45.69
376.80.028	NFC					44.13
376.80.029	NFC					124.28
376.80.030	NFC					125.49
376.80.034	NFC					125.99
376.80.040	NFC					129.94
376.80.044	NFC					93.46
376.80.045	NFC					141.85
376.80.046	NFC					129.34
376.80.052	NFC					100.10
376.80.058	NFC					156.91
376.80.059	NFC					138.94
376.80.062	NFC					138.84
376.80.064	NFC					
376.80.072	NFC					
376.80.073	NFC					92.50
376.80.080	NFC					90.51
376.80.082	NFC					91.84
376.80.086	NFC					
376.80.087	NFC					135.22
376.80.089	NFC					
376.80.092	LNF					51.40
376.80.100	LNF					70.13
376.80.101	LNF					10.48

[a] A negative number indicates that the bull trout moved downstream from its tagging location.

[b] Date located at maximum number migration is within 15 days of actual date due to flight schedule.

Appendix C. Mean migration distances for each watershed group in the North Fork Clearwater River Drainage in 2003.

Mainstem North Fork Clearwater River Watershed Groups.

	Beaver Creek	Cold Springs Creek	Headwaters NFCR	Isabella Creek	Kelly Creek	Long Creek	Lost Pete Creek	Schofield Creek	Skull Creek	Upper Kelly Creek	Upper Weitas Creek	Upper Cayuse Creek
Mean	29.7	84.4	135.3	10.2	99.5	127.0	57.0	51.3	37.3	124.4	73.9	117.3
Standard Error	19.9	1.9	4.7	0.9	4.5	8.7	3.1	13.8	6.8	9.9	5.1	4.4
Median	29.7	84.4	127.5	9.4	99.5	113.6	57.0	50.6	28.9	122.5	73.9	117.3
Standard Deviation	28.1	2.7	19.5	2.4	6.4	26.0	4.5	23.8	16.7	26.1	7.2	6.2
Sample Variance	789.6	7.1	378.7	5.8	40.8	673.5	19.8	567.2	280.0	681.6	51.9	38.4
Minimum	9.8	82.5	107.6	7.1	95.0	98.1	53.8	27.8	24.4	99.0	68.8	113.0
Maximum	49.6	86.3	169.2	14.3	104.0	167.4	60.1	75.4	59.0	179.6	79.0	121.7
Sample Size	2.0	2.0	17.0	8.0	2.0	9.0	2.0	3.0	6.0	7.0	2.0	2.0

Mainstem Little North Fork Clearwater River watershed groups

	Middle LNF	Floodwood Creek	Stony Creek	Upper LNF
Mean	19.3	10.8	13.8	42.7
Standard Error	3.3	5.4	2.5	2.8
Median	19.9	6.1	13.8	40.4
Standard Deviation	12.0	10.8	3.5	14.0
Sample Variance	144.7	116.9	12.5	197.0
Minimum	3.8	3.9	11.3	14.3
Maximum	47.3	26.9	16.3	68.3
Sample Size	13.0	4.0	2.0	26

All Watershed Groups

North Fork Clearwater River Drainage	
Mean	69.5
Standard Error	3.8
Median	54.4
Standard Deviation	47.7
Sample Variance	2270.9
Minimum	3.8
Maximum	179.6
Sample Size	159.0

Appendix D. Density of fish identified during snorkel surveys in the North Fork Clearwater River Drainage, 2003.

Stream	Transect	Area (m^2)	Rainbow trout/100m^2			Cutthroat trout/100m^2			Bull trout/100m^2		
			<305 mm	>305 mm	Total	<305 mm	>305 mm	Total	<350 mm	>350 mm	Total
Beaver Creek	37-24	983	1.83	0.00	1.83	1.53	0.00	1.53	0.10	0.10	0.20
Beaver Creek	41-21 / 8-20	751	0.71	0.40	1.11	3.66	0.00	3.66	0.00	0.27	0.27
Beaver Creek	Random 1.9	1,107	3.36	0.09	3.45	0.81	0.00	0.81	0.00	0.00	0.00
Beaver Creek	BC-1	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beaver Creek	BC-2	227	0.00	0.88	0.88	0.00	0.00	0.00	0.00	0.00	0.00
Bostonia Creek	39-20	646	1.02	0.00	1.02	0.00	0.00	0.00	0.46	0.15	0.62
Bostonia Creek	Random BSA 3.3	265	1.12	0.00	1.12	0.00	0.00	0.00	0.75	0.38	1.13
Collins Creek	Random CNC 4.3	1,020	7.53	0.20	7.72	3.25	0.20	3.45	0.00	0.00	0.00
Floodwood Creek	6-24	1,312	1.73	0.24	1.97	0.00	0.00	0.00	0.00	0.16	0.16
Floodwood Creek	7-24	1,100	3.97	0.26	4.23	0.20	0.00	0.20	0.00	0.13	0.13
Floodwood Creek	35-24	1,233	3.86	0.00	3.86	0.81	0.08	0.89	0.00	0.08	0.08
Floodwood Creek	39-24	767	4.17	0.27	4.44	0.20	0.00	0.20	0.00	0.00	0.00
Floodwood Creek	Random FLD 10.8	1,246	1.42	0.08	1.50	0.10	0.00	0.10	0.08	0.00	0.08
Foehl Creek	40-20	733	1.63	0.27	1.90	3.46	0.55	4.00	0.00	0.27	0.27
French Creek	FC-1	193	2.03	0.00	2.03	0.92	0.00	0.92	0.00	0.00	0.00
French Creek	FC-2	91	1.53	1.10	2.62	1.53	0.00	1.53	0.00	0.00	0.00
French Creek	FC-3	221	0.51	0.00	0.51	3.15	0.00	3.15	0.00	0.00	0.00
Glover Creek	21-24	640	3.66	0.00	3.66	0.20	0.00	0.20	0.00	0.16	0.16
Goose Creek	48-20	910	1.12	0.00	1.12	0.10	0.00	0.10	0.44	0.22	0.66
Hemlock Creek	Random 1	234	0.20	0.00	0.20	0.10	0.00	0.10	0.00	0.00	0.00
Hemlock Creek	Random 2	240	0.20	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Hemlock Creek	Random 3	184	1.22	0.00	1.22	0.00	0.00	0.00	0.00	0.00	0.00
Isabella Creek	17-20	996	8.14	0.00	8.14	0.31	0.00	0.31	0.00	0.10	Isabella Creek
Isabella Creek	18-20	806	4.58	0.37	4.95	1.53	0.12	1.65	0.12	0.25	Isabella Creek
Isabella Creek	3-21 / 5-20	1,134	2.95	0.00	2.95	1.02	0.00	1.02	0.00	0.18	Isabella Creek
Isabella Creek	36-20	1,545	4.88	0.13	5.01	3.15	0.06	3.22	0.00	0.13	Isabella Creek
Isabella Creek	41-21	1,053	2.95	0.09	3.04	3.25	0.00	3.25	0.00	0.19	Isabella Creek

Appendix D. Continued.

Stream	Transect	Area (m^2)	Rainbow trout/100m^2			Cutthroat trout/100m^2			Bull trout/100m^2		
			<305 mm	>305 mm	Total	<305 mm	>305 mm	Total	<350 mm	>350 mm	Total
Isabella Creek	44-24	1,111	4.07	0.18	4.25	0.92	0.00	0.92	0.09	0.18	0.27
Isabella Creek	Random	1,023	4.98	0.20	5.18	1.02	0.00	1.02	0.00	0.00	0.00
Isabella Creek	IC-1	225	1.53	0.00	1.53	0.10	0.00	0.10	0.00	0.00	0.00
Isabella Creek	IC-2	123	0.20	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Isabella Creek	IC-3	171	0.20	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Kelly Creek	34-24 Random KLY 22.4	833	1.32	0.36	1.68	0.71	0.00	0.71	0.00	0.12	0.12
Kelly Creek	43-24	1,082	1.32	0.09	1.41	0.41	0.00	0.41	0.00	0.09	0.09
Kelly Creek	Random KLY 19.7	1,233	0.41	0.08	0.49	0.61	0.16	0.77	0.00	0.00	0.00
Kelly Creek	39-21	841	2.03	0.71	2.75	0.20	0.00	0.20	0.12	0.59	0.71
Kelly Creek (NF)	7-21	909	0.71	0.30	1.01	0.10	0.00	0.10	0.10	0.00	0.10
Kelly Creek (NF)	20-20	1,013	1.22	0.11	1.33	0.31	0.00	0.31	0.00	0.11	0.11
Lake Creek	22-21	1,209	2.14	0.17	2.30	0.61	0.00	0.61	0.08	0.25	0.33
Lake Creek	29-24	644	1.12	0.00	1.12	0.00	0.00	0.00	0.47	0.62	1.09
Lake Creek	Random 3.6	1,200	1.53	0.00	1.53	0.41	0.00	0.41	0.00	0.00	0.00
Lake Creek	Random 8.1	980	0.61	0.00	0.61	0.10	0.00	0.10	0.00	0.00	0.00
Little Moose Creek	LMSC-1	217	0.10	0.46	0.56	0.00	0.00	0.00	0.00	0.00	0.00
Little Moose Creek	LMSC-2	196	0.51	0.00	0.51	0.20	0.00	0.20	0.00	0.00	0.00
Little Moose Creek	LMSC-3	113	1.42	0.00	1.42	0.31	0.00	0.31	0.00	0.00	0.00
Little North Fork Clearwater River	4-20	686	1.53	0.00	1.53	0.00	0.00	0.00	0.07	0.00	0.07
Little North Fork Clearwater River	5-21	1,083	1.93	0.09	2.03	0.00	0.00	0.00	0.00	0.00	0.00
Little North Fork Clearwater River	5-21	758	1.22	0.00	1.22	0.51	0.00	0.51	0.00	0.00	0.00
Little North Fork Clearwater River	12-20	2,000	2.03	1.90	3.93	0.71	0.15	0.86	0.00	0.44	0.44
Little North Fork Clearwater River	139-25 / 49-21	1,188	0.92	0.00	0.92	0.71	0.00	0.71	0.09	0.09	0.18
Little North Fork Clearwater River	139-25 A	1,083	1.02	0.26	1.28	0.10	0.00	0.10	0.26	0.26	0.53
Little North Fork Clearwater River	142-25	1,040	0.92	0.00	0.92	0.81	0.00	0.81	0.00	0.10	0.10
Little North Fork Clearwater River	142-25	710	1.73	0.00	1.73	0.00	0.00	0.00	0.00	0.34	0.34
Little North Fork Clearwater River	18-21	1,387	2.75	1.57	4.31	0.41	0.09	0.50	0.09	0.09	0.18

Appendix D. Continued.

Stream	Transect	Area (m^2)	Rainbow trout/100m2 <305 mm	Rainbow trout/100m2 >305 mm	Rainbow trout/100m2 Total	Cutthroat trout/100m2 <305 mm	Cutthroat trout/100m2 >305 mm	Cutthroat trout/100m2 Total	Bull trout/100m2 <350 mm	Bull trout/100m2 >350 mm	Bull trout/100m2 Total
Little North Fork Clearwater River	19-21	800	3.25	0.10	3.35	0.10	0.00	0.10	0.10	0.10	0.19
Little North Fork Clearwater River	20-21	1,297	0.92	0.42	1.34	0.41	0.00	0.41	0.14	0.42	0.56
Little North Fork Clearwater River	25-20	1,110	1.42	0.29	1.71	0.31	0.07	0.38	0.14	0.07	0.22
Little North Fork Clearwater River	28-20	850	1.83	0.00	1.83	0.31	0.00	0.31	0.25	0.13	0.38
Little North Fork Clearwater River	28-20	583	3.36	0.00	3.36	0.31	0.00	0.31	0.08	0.23	0.31
Little North Fork Clearwater River	31-24	1,678	0.81	0.72	1.53	0.61	0.00	0.61	0.00	0.09	0.09
Little North Fork Clearwater River	32-21	1,751	0.51	0.35	0.86	0.00	0.00	0.00	0.12	0.24	0.35
Little North Fork Clearwater River	33-21	1,470	0.51	0.00	0.51	0.31	0.00	0.31	0.00	0.86	0.86
Little North Fork Clearwater River	38-21	733	2.54	0.77	3.32	0.61	0.06	0.67	0.24	0.06	0.30
Little North Fork Clearwater River	40-21	957	1.53	0.00	1.53	0.10	0.00	0.10	0.17	0.11	0.29
Little North Fork Clearwater River	42-20	387	2.54	0.00	2.54	0.31	0.00	0.31	0.41	0.00	0.41
Little North Fork Clearwater River	43-20 A	1,068	1.53	0.00	1.53	0.20	0.00	0.20	0.00	0.31	0.31
Little North Fork Clearwater River	50-20	2,133	2.14	2.59	4.72	0.51	0.00	0.51	1.03	0.78	1.81
Little North Fork Clearwater River	50-24	1,768	0.41	0.28	0.69	0.10	0.00	0.10	0.09	0.09	0.19
Little North Fork Clearwater River	Random 14	1,216	0.71	0.08	0.79	0.00	0.00	0.00	0.00	0.00	0.00
Little North Fork Clearwater River	Random 16	1,568	0.61	0.06	0.67	0.31	0.00	0.31	0.00	0.00	0.00
Little North Fork Clearwater River	Random 18	1,515	0.71	0.00	0.71	0.10	0.00	0.10	0.40	0.07	0.46
Little North Fork Clearwater River	Random LNF 2.5	2,584	1.22	0.08	1.30	0.61	0.08	0.69	0.19	0.08	0.27
Long Creek	10-21	666	2.64	0.00	2.64	0.00	0.00	0.00	1.50	0.00	1.50
Long Creek	134-25	725	0.81	0.14	0.95	0.00	0.00	0.00	0.00	0.28	0.28
Long Creek	Random LNG 5.2	755	2.03	0.00	2.03	0.20	0.00	0.20	0.00	0.00	0.00
Lost Creek	137-25	233	2.34	0.00	2.34	0.20	0.00	0.20	0.00	3.00	3.00
Moose Creek	Random MSC 2.2	1,533	1.32	0.20	1.52	0.00	0.00	0.00	0.00	0.13	0.13
Black Canyon	18-24	1,962	0.31	0.51	0.81	0.00	0.00	0.00	0.05	0.15	0.20
Black Canyon	22-20	4,133	0.61	0.27	0.88	0.71	0.05	0.77	0.05	0.00	0.05
Black Canyon	24-20	1,867	1.63	0.39	2.01	0.00	0.02	0.02	0.00	0.10	0.10
Black Canyon	29-21 A	2,167	0.81	0.37	1.18	0.00	0.00	0.00	0.00	0.05	0.05
Black Canyon	73-7	2,033	2.03	0.25	2.28	0.20	0.05	0.25	0.05	0.20	0.25

Appendix D. Continued.

Stream	Transect	Area (m^2)	Rainbow trout/100m2 <305 mm	Rainbow trout/100m2 >305 mm	Rainbow trout/100m2 Total	Cutthroat trout/100m2 <305 mm	Cutthroat trout/100m2 >305 mm	Cutthroat trout/100m2 Total	Bull trout/100m2 <350 mm	Bull trout/100m2 >350 mm	Bull trout/100m2 Total
Black Canyon	Random 10.7	3,605	0.51	0.33	0.84	0.20	0.00	0.20	0.17	0.06	0.22
Black Canyon	Random 11.3	3,600	0.61	0.58	1.19	0.00	0.00	0.00	0.03	0.03	0.06
Niagara Gulch	46-21	307	0.92	0.00	0.92	0.00	0.00	0.00	0.98	0.33	1.30
Niagara Gulch	Random NG 0.1	425	0.51	0.00	0.51	0.00	0.00	0.00	1.88	0.00	1.88
Niagara Gulch	Random NG 1.1	470	1.63	0.00	1.63	0.00	0.00	0.00	0.00	0.00	0.00
North Fork Clearwater River	8-21	1,633	1.02	0.03	1.05	0.10	0.00	0.10	0.00	0.00	0.00
North Fork Clearwater River	11-21	2,390	1.12	0.18	1.30	0.00	0.00	0.00	0.00	0.12	0.12
North Fork Clearwater River	18-24	2,424	1.12	0.13	1.24	0.20	0.00	0.20	0.13	0.04	0.17
North Fork Clearwater River	27-20	1,986	0.00	0.12	0.12	0.20	0.00	0.20	0.00	0.04	0.04
North Fork Clearwater River	30-20	2,424	1.22	0.35	1.57	0.20	0.00	0.20	0.00	0.15	0.15
North Fork Clearwater River	34-21	2,000	0.41	0.21	0.61	0.00	0.00	0.00	0.00	0.21	0.21
North Fork Clearwater River	38-24	1,867	1.22	0.95	2.17	0.10	0.00	0.10	0.00	0.15	0.15
North Fork Clearwater River	39-20	1,500	0.41	0.11	0.51	0.00	0.00	0.00	0.05	0.21	0.27
North Fork Clearwater River	4-21/34-21	2,170	0.61	0.27	0.88	0.51	0.00	0.51	0.00	0.07	0.07
North Fork Clearwater River	44-21	2,167	0.10	0.05	0.15	0.00	0.00	0.00	0.00	0.14	0.14
North Fork Clearwater River	46-20	2,278	0.81	0.46	1.28	0.00	0.09	0.09	0.00	0.00	0.00
North Fork Clearwater River	64-7	3,467	0.31	0.09	0.39	0.10	0.04	0.15	0.00	0.00	0.00
North Fork Clearwater River	Random NF 5.5	2,700	0.31	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00
Orogrande Creek	UOC-1	388	0.51	0.00	0.51	0.00	0.00	0.00	0.26	0.77	1.03
Orogrande Creek	UOC-2	413	0.51	0.24	0.75	0.00	0.00	0.00	0.00	0.00	0.00
Orogrande Creek	UOC-3	340	0.20	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Placer Creek	47-20	277	0.20	0.00	0.20	0.00	0.00	0.00	2.16	0.00	2.16
Quartz Creek	23-20	7,979	1.93	0.06	1.99	0.31	0.00	0.31	0.01	0.00	0.01
Quartz Creek	49-24	986	5.69	0.10	5.80	3.05	0.10	3.15	0.00	0.10	0.10
Rutledge Creek	13-20	761	0.92	0.00	0.92	0.00	0.00	0.00	0.00	0.39	0.39
Rutledge Creek	Random RTG 0.1	501	0.81	0.00	0.81	0.00	0.00	0.00	0.00	0.20	0.20
Skull Creek	15-21	1,309	1.53	0.38	1.91	0.20	0.00	0.20	0.00	0.00	0.00
Skull Creek	15-21/40-21	1,470	4.37	0.41	4.78	0.31	0.00	0.31	0.00	0.14	0.14

Appendix D. Continued.

Stream	Transect	Area (m^2)	Rainbow trout/100m2 <305 mm	Rainbow trout/100m2 >305 mm	Rainbow trout/100m2 Total	Cutthroat trout/100m2 <305 mm	Cutthroat trout/100m2 >305 mm	Cutthroat trout/100m2 Total	Bull trout/100m2 <350 mm	Bull trout/100m2 >350 mm	Bull trout/100m2 Total
Skull Creek	16-21	750	0.92	1.33	2.25	0.61	0.00	0.61	0.00	0.27	0.27
Skull Creek	20-24	1,392	0.71	0.07	0.78	2.44	0.00	2.44	0.00	0.07	0.07
Skull Creek	20-24	1,503	2.95	0.33	3.28	0.61	0.00	0.61	0.00	0.07	0.07
Skull Creek	43-21	1,267	3.66	0.32	3.98	0.31	0.00	0.31	0.00	0.00	0.00
Skull Creek	45-20	1,666	3.97	0.06	4.03	0.71	0.00	0.71	0.06	0.06	0.12
Skull Creek	48-21	1,467	1.63	0.75	2.38	4.07	0.20	4.27	0.00	0.07	0.07
Skull Creek	48-21	1,600	4.58	0.00	4.58	0.61	0.00	0.61	0.00	0.00	0.00
Skull Creek	Random SKL 14.9	737	1.83	0.14	1.97	0.71	0.14	0.85	0.00	0.00	0.00
Skull Creek	Random SKL 15.3	654	2.64	0.00	2.64	1.83	0.15	1.98	1.22	0.15	1.38
Skull Creek	SC-2	104	2.44	0.00	2.44	0.81	0.00	0.81	11.54	3.85	15.38
Skull Creek	SC-3	527	1.93	0.19	2.12	0.92	0.19	1.11	0.95	1.52	2.47
Skull Creek	SC-4	692	2.54	0.58	3.12	0.20	0.00	0.20	1.01	0.87	1.88
Upper NFC	8-21	575	0.61	0.00	0.61	0.00	0.00	0.00	2.09	1.04	3.13
Upper NFC	Random UNF 5.8 / 11-21	832	0.61	0.00	0.61	0.00	0.00	0.00	0.72	0.96	1.68
Vanderbilt Gulch	4-21	847	1.22	0.00	1.22	0.00	0.00	0.00	0.00	0.25	0.25
Vanderbilt Gulch	23-21	869	1.22	0.00	1.22	0.00	0.00	0.00	0.47	0.35	0.83
Vanderbilt Gulch	30-20	983	0.81	0.00	0.81	0.00	0.00	0.00	0.58	0.12	0.69
Vanderbilt Gulch	3-20 / 34-20	810	0.51	0.00	0.51	0.00	0.00	0.00	0.00	0.20	0.20
Vanderbilt Gulch	46-20	719	1.53	0.00	1.53	0.00	0.00	0.00	0.00	0.00	0.00
Vanderbilt Gulch	Random VG 8.6	1,020	0.20	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Weitas Creek	2-20	1,760	0.00	1.02	1.02	0.20	0.00	0.20	0.00	0.00	0.00
Weitas Creek	37-20	1,472	0.51	1.97	2.48	0.10	0.07	0.17	0.00	0.00	0.00
Weitas Creek	Random (Annual site)	653	0.00	0.77	0.77	0.00	0.00	0.00	0.00	0.00	0.00
Weitas Creek	Random 10.1	1,536	0.41	0.20	0.60	0.10	0.00	0.10	0.00	0.00	0.00

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